ISSN 0976-7479

Arthaniti

(New Series)
Volume X (Nos. 1-2), 2011

EDITORIAL BOARD

Editors

Sarbajit Chaudhuri
Sankar Kumar Bhaumik

Associate Editors

Anjan Chakraborty
Kumarjit Mandal
Sukanta Bhattacharyya

Book Review Editors

Sudakshina Gupta
Arijita Datta

Members

Asis Kumar Banerjee,
Arup Mallik,
Ajit Choudhury,
Kalyan Sanyal,
Sarmila Banerjee,
Manash Ranjan Gupta,
Sugata Marjit,
Dipankar Coondoo,
Abhirup Sarkar,
Mahalaya Chatterjee,
Biswajit Roy.

Editorial Advisory Board

Ronald W Jones,
Timothy Besley,
Sajal Lahiri,
Partha Sen,
Soumyen Sikdar,
Prasanta K. Pattanaik,
Rabindra Nath Bhattacharya,
Prabuddha Nath Roy,
Amiya K Bagchi,
Dilip Mookherjee,
Pasquale M Sgro,
Debraj Ray,
Hiron Kumar Banerjee,
David E A Giles,
Bharat R Hazari,
Hamid Beladi,
Graciela Chichilnisky,
Ira Gang,
Shigemi Yabuuchi,
Ulaganathan Sankar

CONTENTS

Debt policy in a competitive two-sector overlapping generations model
Partha Sen

Mixed Duopoly with Price Competition
Prabal Roy Chowdhury and
Indrani Roy Chowdhury

Understanding Foreign Aid in an Endogenous Model of North-South Global Relations
Ajitava Raychaudhuri and Jayati Bhattacharya

Empirics of Child Labour and the inverted U: A Pluralistic approach
Atanu Sengupta and Manas Ghose

Book Review

Editorial /Bussiness Office :
Department of Economics
University of Calcutta
56A, B.T. Road, Kolkata - 700 050, India
Tel. : 91-33-2557-5082, 91-33-2528-4066
Fax : 91-33-2528-4066
e-mail : sarbajitch@yahoo.com

(10)

ISSN 0976-7479

ARTHANITI (ECONOMICS)

(New Series)

Aims and scope: The Department of Economics, University of Calcutta has resumed the publication of its journal Arthaniti (Economics) from 2002. For the time being, Arthaniti is published as an annual international journal. Papers across the entire field of economics, including econometrics, economic history, and political economy will be considered for publication. Both theoretical and empirical manuscripts are equally welcome.

Manuscripts will be judged solely on the quality of their content. Arthaniti will adopt a double-blind review process. The editorial board will not reveal the identities of either authors or referees to other parties in the review process. The editor and/or any member of the editorial board will send submitted papers to the referees only after an initial reading. The editorial board reserves the right to reject any paper at that stage. However, most of the submitted papers will be sent to the referees for comments.

EDITORIAL BOARD

Editors

Sarbajit Chaudhuri (E-mail: sarbajitch@yahoo.com)
Sankar Kumar Bhaumik (E-mail: bhaumiksk@yahoo.co.in)

Associate Editors

Anjan Chakraborty (E-mail: chakanjana@yahoo.co.in)
Kumarjit Mandal (E-mail: kumarjitm@hotmail.com)
Sukanta Bhattacharyya (sukanta_70@yahoo.com)

Book Review Editors

Sudakshina Gupta (E-mail: sudakshinagupta@yahoo.co.in)
Arijita Datta (E-mail: dutta.arijita@gmail.com)

Members:

Asis Kumar Banerjee, Arup Mallik, Ajit Choudhury, Kalyan Sanyal, Soumyen Sikdar, Sarmila Banerjee, Manash Ranjan Gupta, Sugata Marjit, Dipankar Coondoo, Abhirup Sarkar, Mahalaya Chatterjee, Biswajit Roy.

G165656

EDITORIAL ADVISORY BOARD

Ronald W Jones, Timothy Besley, Sajal Lahiri, Partha Sen, Prasanta K. Pattanaik, Rabindra Nath Bhattacharya, Prabuddha Nath Roy, Amiya K Bagchi, Dilip Mookherjee, Pasquale M Sgro, Debraj Ray, Hiron Kumar Banerjee, David E A Giles, Bharat R Hazari, Hamid Beladi, Graciela Chichilnisky, Ira Gang, Shigemi Yabuuchi, Ulaganathan Sankar

CUK-H00550-10-0716565b

ISSN 0976-7479

140/10

ARTHANITI
(ECONOMICS)

(New Series)

Volume X (Nos. 1-2), 2011

Special Editor : *Mahalaya Chatterjee*
Head, Department of Economics
University of Calcutta

CONTENTS

Debt policy in a competitive two-sector overlapping generations model
Partha Sen *3 - 15*

Mixed Duopoly with Price Competition *16 - 37*
Prabal Roy Chowdhury and Indrani Roy Chowdhury

Understanding Foreign Aid in an Endogenous Model of North-South Global Relations *38 - 69*
Ajitava Raychaudhuri and Jayati Bhattacharya

Empirics of Child Labour and the inverted U: A Pluralistic approach *70 - 91*
Atanu Sengupta and Manas Ghose

Book Review *91 - 94*

Partha Sen /Arthaniti 10 (1-2), I-II / 2011 /3

Debt Policy in a Competitive Two-Sector Overlapping Generations Model

Partha Sen
Department of Economics, Delhi School of Economics, Delhi 110007, India
E-mail: partha@econdse.org
Fax: (91)-11-2766-7125

ABSTRACT

The Maastricht Treaty has revived interest in analyses of government debt. What are the positive and normative effects of debt? On the normative aspect, an increase in debt in one-sector life-cycle models benefits those who are alive on date one, and is definitely welfare reducing in the steady state. In a two-sector model, debt issued to transfer resources to the initially old, is welfare improving in the new steady state even for a dynamically efficient economy. The only potential losers are the initially old, if the interest rate falls sufficiently to offset the effect of the transfer—this is reminiscent of the transfer paradox in trade theory.

JEL Classification: E2, E6.

Keywords: Government Debt, Overlapping Generations, Two-Sector Models, Dynamic Efficiency.

Acknowledgement: I wish to thank Karl Shell, Philippe Weil, V. Bhaskar, Roger Guesnerie, Nobu Kiyotaki, and Tim van Zandt for helpful discussion and comments.

1. Introduction

The issue of the size of government debt to GDP has become an important point of debate following the Maastricht Treaty. This treaty would cap the debt /GDP ratio at 60 per cent. Government debt has implications for intergenerational welfare—the so-called generational accounts—and it is also believed (though not universally) to determine the price level. The macroeconomics literature has attempted to grapple with the issue of debt policy in a life-cycle (overlapping generations) framework. With infinitely lived agents, Ricardian equivalence holds as long as the choice of financing a given path of government expenditure is limited to borrowing or lump-sum taxes (see Persson (1985) for a discussion in a two period framework; Weil (1991) discusses the relationship between Ricardian non-equivalence and superneutrality; also see Bhattacharya et al. (2004) for a discussion of these issues).

In one-sector two-period competitive overlapping generations models, capital is crowded out if a transfer is made by the government to the old in the initial period and this is financed by issuing debt. The generation receiving the handout gains as also the next generation. The former gain because both their savings and the return on these is fixed and hence their real income goes up due to the transfer. The generation born in the period that the transfer is made gains because (i) their wages are predetermined, (ii) the interest rate on their savings rises as a consequence of a lower stock of capital—this is due to the fact that debt crowds out capital—and (iii) they do not need to service the debt. In a closed economy the steady state welfare is lower due to the crowding out of capital. This is because a part of the savings of the young now has to be allocated to the holding of the debt, and, in addition, taxes have to be raised to pay the interest burden that the debt imposes.[1] All this presumes that the economy is dynamically efficient i.e., in a one sector framework the interest rate (r) is not less than the population growth rate (n) (or equivalently profits are at least as much as investment—see Phelps (1965) and Abel et al.

(1989)). In other words, the capital stock is less than the one associated with Phelps' "Golden Rule".[2]

---

[1] See Persson (1985) for a discussion of this both in an open economy and a closed economy framework of Diamond (1965). Shell (1971), Buiter (1981), and Matsuyama (1991) discuss dynamic efficiency and overaccumulation in overlapping generations models. For analyses of debt in dynamic macroeconomic models also see Rankin (1986), Rankin and Roffia (2003), Meijdam et al. (1996), Gertler (1999). Grinols and Turnovsky (1998)), Ihori (1978), (1996), Buiter and Kletzer (1992), Chalk (2000), Lin (2000). Nielsen (1992) and Jensen and Nielsen (1995).

[2] In a one-sector two-period overlapping generations set-up, Chalk (2000) and Rankin and Roffia (2003) look at sustainability of public debt. Our interest is on normative issues.

I disaggregate the production structure and analyze debt policy in a competitive two-sector life-cycle model—see e.g., Galor (1992), Azariadis (1993) and Cremers (2005). I look at the effect of an increase in government debt on welfare, especially in the new steady state in a tractable version of the two-sector model, akin to Calvo (1978). In such a set up, public debt issued to finance transfers to the old increases the steady state welfare (under very reasonable conditions) in an economy which satisfies the usual conditions for dynamic efficiency viz. r > n. This happens not because the stock of capital changes—capital accumulation is left untouched in my model—but because relative prices (including factor earnings) do. The real wage rate rises and the real interest rate falls along the adjustment path and in the steady state—this is to crowd out the increased aggregate demand since the old spend all their income and it is they that receive the transfer. The fall in the rate of interest takes the economy towards the "Golden Rule".

The rest of the paper is organized as follows: in section 2, I set out the model. Debt policy is introduced in section 3, while section 4 concludes. An Appendix derives some tedious expressions used in the text.

2. The model

The economy consists of overlapping generations of individuals or households. Each household lives for two periods. It supplies one unit of labour in the first period of its life and in the second period consumes the saving from the first period plus the return on these savings. There are no bequests or inheritances. The population is constant. The analysis is conducted by taking a log-linear approximation (around the initial steady state—one without debt) to the various behavioural and market-clearing equations.

The representative household born in time period t maximizes the following utility function.

$$U_t = \log C_t^t + (1+\rho)^{-1} \log C_{t+1}^t$$

where C_{t+i}^t is the consumption in period t+i of a household born in t and $\rho > 0$ is the rate of time preference.

Its lifetime budget constraint (without taxes, which are introduced later) is
$W_t = C_t^t + (1+r_{t+1})^{-1}.C^t_{t+1}$

Where W_t is the wage rate in time period t and r_{t+1} the own interest rate on one period consumption loans between t and t+1.

This yields

$$C_t^t = [(1+\rho)/(2+\rho)]W_t \tag{1a}$$

$$C_{t+1}^t = [(1+r_{t+1})/(2+\rho)]W_t \tag{1b}$$

$$S_t \equiv \arg\max\{\log(W_t - S_t) + (1+\rho)^{-1}\log((1+r_{t+1}).S_t)\} = (2+\rho)^{-1}\, W_t \tag{2}$$

Where S_t is the saving in period t. Given the logarithmic form of the utility function we have a proportion $1/(2+\rho)$ of labour income saved by the young.

The indirect utility function is given by (m is a constant)

$$V_t = m + [(2+\rho)\log W_t + \log(1+r_{t+1})]/(1+\rho) \tag{3}$$

The production side of the economy is represented by the two cost-equal-to-price equations[3] The consumption good (C) and the investment good (I) are produced under conditions of constant returns to scale with Leontief technologies using the two inputs, capital (K) and labour (L). All inputs are mobile between sectors instantaneously. Capital is assumed to depreciate completely in the process of production — not a bad assumption for a model where a single period corresponds to about 35 to 40 years![4]

$$a_{LI}.W_t + a_{KI}.R_t = p_t \tag{4}$$

$$a_{LC}.W_t + a_{KC}.R_t = 1 \tag{5}$$

Where a_{ij} is the (fixed) requirement of the i^{th} input (i = K, L) in the production of the j^{th} good (j = C, I), and p is the relative price of the investment good in terms of the numeraire consumption good. R is the gross return on capital. Since we assume capital depreciates completely in the process of production, we have in equilibrium : $(1+r_{t+1}) = R_{t+1} / P_t$

---

[3] See e.g., Matsuyama (1988) for a similar set-up, though in an open economy context.

[4] This is for analytical convenience only and is made elsewhere in the literature e.g., Cremers (2001). Dropping this would require capital gains on the sale of capital to be part of the return to holding of capital. That would still leave the steady state, where there are no capital gains, unaffected.

There are two goods markets and two factor markets. By Walras' Law, if three of these are in equilibrium in any period, then so is the fourth one. We thus have

$$a_{LC}.C_t + a_{LI}.I_t = 1 \quad (6a)$$

$$a_{KC}.C_t + a_{KI}.I_t = k_t \quad (6b)$$

$$p_t.I_t = S_t = (2+\rho)^{-1} W_t \quad (6c)$$

Equations (6a), (6b) and (6c) are the market clearing conditions for the labour, capital and investment goods markets respectively. The variable C_t is the production per worker of the consumption good I_t is the output per worker of the investment good, S_t is the saving per head of the young in period t (see equation (2) above) and k_t is the capital stock per worker (all in time period t). The constant population size is normalised to two and thus the number of workers is one.

Finally, the dynamics of the economy is represented by

$$k_{t+1} = I_t \quad (7)$$

i.e., investment goods become capital in the following period. Note that in equation (7), the population growth rate is assumed (implicitly) to be zero.

Log-linearising (4) and (5) around the initial steady state, where there is no debt, yield

$$\theta_{LC}.\hat{W}_t + \theta_{KC}.\hat{R}_t = 0 \quad (8a)$$

$$\theta_{LI}.\hat{W}_t + \theta_{KI}.\hat{R}_t = \hat{P}_t \quad (8b)$$

Where θ_{ij} is the share of the i^th^ *input in the* j^th^ sector price and a hat over a variable denotes a proportionate change (e.g., $\theta_{LC} \equiv a_{LC}.W/p$ and $\hat{x} \equiv dx/x$).[5]

From (8a) and (8b) we have

$$P_t / \hat{W}_t = -\Delta / \theta_{KC} \quad (9a)$$

$$\hat{R}_t / \hat{W}_t = -\theta_{LC} / \theta_{KC} \qquad (9b)$$

where $\Delta \equiv \theta_{LC} - \theta_{LI} = \theta_{KC} - \theta_{KC}$

Equations (9a) and (9b) imply

$$(\hat{R}_t - \hat{P}_t) / \hat{W}_t = -\theta_{LI} / \theta_{KC} \qquad (9c)$$

From (6a), (6b) and (6c) have by log-linearising

$$\lambda_{LC}.\hat{C}_t + \lambda_{LI}.\hat{I}_t = 0 \qquad (10a)$$

$$\lambda_{LC}.\hat{C}_t + \lambda_{LI}.\hat{I}_t = \hat{k}_t \qquad (10b)$$

$$\hat{p}_t + \hat{I}_t = \hat{W}_t \qquad (10c)$$

Where λ_{ij} is the share of the j^{th} sector in the total employment of the input. In (10a) and (10b) we have used the assumption that technologies in both sectors are Leontief i.e., the elasticities of substitution between inputs are zero.

In equations, (8a), (8b), (10a), (10b) and (10c), we have five equations in six unknowns. We can solve these for $\hat{W}_t, \hat{R}_t, \hat{p}_t, \hat{C}_t$ and $\hat{I}_t$ in terms of $\hat{k}_t$.

Equation (7) can be linearised around the steady state and written as

$$dk_{t+1} = (\partial I / \partial k).dk_t \qquad (11)$$

Where $dk_{t+i} \equiv k_{t+i} - k$ is the deviation of the t+i capital per worker from its steady state value k (a variable's steady state value is denoted without a time subscript). Note that $\partial I / \partial k$ is $\hat{I}_t / \hat{k}_t$ evaluated at the steady state.

Substituting for $\hat{I}_t$ from (10a) and 10(b) into (11) we have

$$dk_{t+1} = \lambda_{LC}.(\lambda_{LC} - \lambda_{KC})^{-1}.dk_t$$

This can only be stable iff

$$-1 < \lambda_{LC}.(\lambda_{LC} - \lambda_{KC})^{-1} < 1$$

which in turn requires $\lambda_{KC} > 2\lambda_{LC}$ i.e., the consumption good is capital intensive —note this implies that $\Delta < 0$ in equation (9a). Thus if the model is

---

5. For an application of the "hat calculus" see e.g., Atkinson and Stiglitz (1980), Chapter 6, Section 2.

stable, the convergence is cyclical. We assume the conditions on the production functions hold which guarantee a non-trivial steady state (see Cremers (2005) for a discussion).

3. Increase in government debt

Suppose starting from a steady state without any debt, in period 1 the government decides to transfer an amount dg to the old (i.e., the generation born on date 0) by issuing one-period bonds. The level of debt is held at this level forever. The interest on the outstanding debt is paid by levying a lump-sum tax on the young every period.[6] We shall see that the economy reaches a new steady state in period 2—all production levels are constant and only relative prices (including factor prices) change. In calculating welfare changes we need to consider (i) the currently old when the policy is introduced (i.e., the generation born on date 0 which receives the transfer), (ii) the generation born in period 1 (they have to hold the debt but there is no debt servicing required yet), and (iii) generation two onwards—these have to hold the debt as part of their portfolios and pay taxes to meet the servicing requirements.

Equation (10c), in period one becomes (all changes are evaluated at the initial equilibrium values)

$$\hat{p}_1 + \hat{I}_1 = \hat{W}_1 - dg(2+\rho)/W \qquad (10c')$$

Equation (10c′) tells us that savings of the young in period 1 have to be allocated between investment and the holding of government debt—the right hand side of the equation being the savings net of bond holdings.

From equations (10a) and (10b) we see that given k_1, $\hat{I}_1$ and $\hat{C}_1$ are both zero—remember with Leontief technology I and C depend only on k through the full employment conditions (6a) and (6b) and not on factor prices.

Hence (10c) becomes (with $\hat{I}_1=0$)

$$\hat{W}_1 - \hat{P}_1 = (2+\rho).dg/W$$

---

[6] Labour is inelastically supplied so a tax on labour is identical to a lump-sum tax.

or (after substituting from (9a) and (9b))

$$dW_1/dg = \{\theta_{KC}/\theta_{KI}\}(2+\rho) > 1 \qquad (12a)$$

$$dR_1/dg = -(\theta_{LC}/\theta_{KI})(R/W)(2+\rho) \qquad (12b)$$

The change in welfare of generation 0 (those receiving g) is[7]

$$dV_0 = dg + kdR_1 = [1+\{(-\theta_{LC})R/(\theta_{KI}.p)\}]dg$$

This is may be positive or negative. The old receive the transfer but the real rate of interest falls as well. The indirect effect of the transfer (i.e., the fall in the interest rate) could easily dominate (i.e., if $\theta_{LC} \geq \theta_{KI}$) and welfare of the old could fall (remember that (R/p))>1—it is the consumption interest factor

Since I_1 does not change neither do I_2 *and* C_2 (since $I_1=k_2$). Thus I, k and C remain unchanged at the initial steady state values. From period 2 onwards the system reaches its steady state—all the effects below are time invariant. The steady state effect of an increase in debt is seen in equation (14)

$$p.I = [W-(Rp^{-1}-1).g]/(2+\rho)-g \qquad (14)$$

Note that time subscripts do not appear for W, R and p because all values are steady state values.

The term within the square brackets on the right hand side of equation (14) is wages net of taxes, which are raised to pay interest on the outstanding debt. Debt is a durable asset, which does not depreciate unlike what we have assumed for capital.

Since across steady states, I remains unchanged we have from equation (15) .

$$\hat{W}/dg = [(Rp^{-1}+1+\rho)/W](\theta_{KC}/\theta_{KI}) \qquad (15)$$

The net-of-tax wage rate has to rise, in order to generate higher savings so that the debt can be willingly held—and hence the (pre-tax) wage rate W has to rise more than g. Note that it is a consequence of assuming a logarithmic utility function that the additional savings can be generated only by a rise in disposable income (and not through changes in R/p as would be the case in a more general utility function).

---

[7] This is just the change in their second period consuption.

From (9a) and (9b), we know that if W rises, both R and p fall (given our capital intensity assumption). It is easy to check from (9c) that R falls more than p, so that R/p falls. The changes are given in equations (16), (17), and (18) below

$$\hat{p} / dg = (-\Delta / \theta_{KI}).[(Rp^{-1} + 1 + \rho) / W] \qquad (16)$$

$$\hat{R} / dg = -(\theta_{LC} / \theta_{KI}).[(Rp^{-1} + 1 + \rho) / W] \qquad (17)$$

$$(\hat{R} - \hat{p}) / dg = -(\theta_{LI} / \theta_{KI}).[(Rp^{-1} + 1 + \rho) / W] \qquad (18)$$

The change in the welfare of generation 1 is given by

$$\hat{V}_1 / dg = [(2 + \rho)^2 \theta_{KC} - (1 + \rho)(1 + \rho + Rp^{-1})\theta_{LI}] / (\theta_{KI} . W . (1 + \rho)) \qquad (19)$$

A necessary and sufficient condition for this expression to be positive (say starting from an initial equilibrium where the consumption interest rate and the rate of time preference are equal i.e., 1+ρ=R/p and given that the rate of time preference is very small), is that (remember that C is capital intensive and I is labour intensive and $\theta_{KC} > \theta_{LI} / 2$ (remember that C is Capital Intensive and I is labour intensive and θ_{KC} and θ_{LI} are shares of factors that C and I respectively intensive in). We shall assume this to be the case. Generation 1 is affected by the transfer solely because they have to generate the savings to absorb the newly issued bonds. Their wages (in period one) rise but the interest rate they face (in period two—i.e., the new steady state) is lower.

In the presence of debt we modify the indirect utility function (equation (3)) for the tax burden required to service the debt (for generation 2 onwards)

$$V = m + [(2 + \rho) \log(W - Rp^{-1} - 1)g) + \log(R / p)] / (1 + \rho) \qquad (20)$$

$$\hat{V} = [(2 + \rho)\{(Rp^{-1} - 1)(-\Delta) + (2 + \rho)\theta_{KC}\} - (1 + \rho)(1 + \rho + rp^{-1})\theta_{LI}] / (W\theta_{KI}(1 + \rho)) \qquad (21)$$

Note that this expression is identical to the one in (19), except for the term $(2+\rho)\Delta(1-Rp^{-1})/(W\theta_{KI}(1+\rho))>0$ So the condition under which welfare rises for generation 1 also delivers a rise in steady state welfare, except that it is weaker (sufficient) condition. The intuition for this very obvious—generation one had a smaller rise in its wage rate than the subsequent generations but the same fall in its interest rate.

Note that it is possible to make everyone (i.e., generation zero onwards) better off for certain parameter values—e.g., if θ_{KC}=0.7, θ_{LI}=0.6 and R/p=1.05 (implying a real consumption rate of interest equal to 5 per cent). We would thus have a Pareto improvement with R/p>1 (=(1+n)), where n the population growth rate is assumed to be zero) but in general there is no such presumption.

The welfare comparison across steady states is shown in Fig.1. On the horizontal axis we have C^1 and on the vertical axis we have C^2. The intercept of the budget line on the horizontal axis is the wage net of taxes and the slope is (—R / *p*). Point E_0 is the initial equilibrium on indifference curve U_0U_0. In the new steady state, the after-tax wage rate rises and the new equilibrium is at E_1 on U_1U_1. Point E_0 and E_1 lie on a straight line CC with a slope of (-1) given that in the new steady state dC=0 (i.e., the total consumption of both the young and the old is unchanged at the level of the initial steady state).

4. Conclusions

In a two-sector model with zero population growth we looked at the effect of an increase in government debt due to increased transfers to the currently old on steady state welfare. We found that debt policy could be welfare improving in the new steady state for an economy which satisfies the usual conditions for dynamic efficiency viz. $r > n = 0$. The only potential losers are the initial older generation (generation 0) who were the recipients of the transfer. This could happen if the interest rate was to fall sufficiently to offset the effect of the transfer. From generation one onwards everyone becomes better off. Debt improves steady state welfare not by changing the stock of capital — capital accumulation is left untouched—but by changing relative prices (including factor earnings). In a one sector model with a smooth technology, the definite gainers are those who are alive on date1. The old in period 1 gain because the transfer increases their incomes, while leaving the interest rate unaffected, and the young because their wage rate is given but the interest rate in their old age rises as a consequence of capital being crowded out.

The results obtained in this paper depend on the assumptions in a critical way. First, a logarithmic utility function means that savings do not depend on the rate of interest and the dynamics of the economy can be represented by a single state variable. Second, the assumption of Leontief technology in the two sectors means (obviously) that technology is not smooth and capital accumulation affects the behaviour of the quantities of the goods produced in the economy through the Rybczinski effects only and not through any induced factor price changes. Third, while the level of output remains unchanged, relative prices change and there is relocation of intertemporal consumption.

Finally, I note that while I have obtained the effects of debt policy in welfare, qualitatively similar welfare results can be obtained even if the production functions in the two sectors were not Leontief. The requirements are: (a) that the consumption good sector is relatively capital intensive (as is required for stability in this paper),[8] and (b) that elasticities of substitution in both sectors be sufficiently low. The capital stock also moves in response to the issuing of debt but the effect on welfare is qualitatively the same as we have obtained in this paper.

---

[8] In the general case, either kind of capital intensity assumption is consistent with stability. It is still true, though, that if the investment good is labour intensive, adjustment is cyclical. This is shown in some notes available from the author.

REFERENCES

Abel, A., Mankiw, N.G., Summers, L.H. and Zeckhauser, R. (1989). 'Assessing dynamic efficiency', *Review of Economic Studies*, **56**, 1 - 19.

Atkinson, A.B., and J.E. Stiglitz (1980) *Lectures in Public Economics*, McGraw Hill, New York.

Azariadis, C. (1993). *Intertemporal Macroeconomics*, Basil Blackwell, Oxford.

Broer, D.P. and Heijdra, B.J. (2001). ' Investment tax credit under monopolistic competition',

Oxford Economic Papers, **53**, 318-51.

Buiter, W.H. (1981). 'Time preference and international lending and borrowing in an overlapping generations model', *Journal of Political Economy*, **89**, 769-97.

Calvo, G. (1978). 'On the indeterminacy of interest rates and wages with perfect foresight', *Journal of Economic Theory*, **19**, 321-37.

Cremers, E. (2005). 'Intergenerational welfare and trade', *Macroeconomic Dynamics*, **9**, 585-611.

Diamond, P. A. (1965). 'National debt in a neoclassical growth model', *American Economic Review*', **55**, 1126-50.

Galor, O. (1992). 'A two-sector overlapping generations model: A characterization of the dynamical system', *Econometrica* , **60**, 1351 - 86.

Gertler, M. (1999). 'Government debt and social security in a life-cycle model', *Carnegie-Rochester Conference on Public Policy*, **50**, 61-110

Grinols, E.L. and Turnovsky, S.J. (1998). 'Consequences of debt policy in a stochastically growing monetary economy'. *International Economic Review*, **39**, 495-521.

Ihori, T. (1978). 'The Golden Rule and the role of a government in a life cycle growth model', *American Economic Review*, **68**, 389-96.

Jensen E. S.-H.and Nielsen,S.B. (1995). 'Population ageing, public debt and sustainable fiscal policies', *Fiscal Studies*, **16**, 1-20.

Lang, G. (1996). *On Overlapping Generations Models with Productive Capital*, Springer-Verlag, Berlin.

Matsuyama, K. (1988). 'Terms of trade, factor intensities and the current account in a life cycle model', *Review of Economics Studies*, **55**, 247-62

Matsuyama, K. (1991). 'Immiserizing growth in Diamond's overlapping generations model: A geometrical exposition', *International Economic Review*, **32**, 251-62.

Meijdam,L., van de Ven,M. and Verbon, H.A.A. (1996). 'The dynamics of

government debt', *European Journal of Political Economy*, **12**, 67-90.

Rankin, N. (1986). 'Overlapping generations, open economy, debt policies under fixed and flexible Prices', *Oxford Economic Papers*, **38**, 481-500.

Persson, T. (1985). 'Deficits and intergenerational welfare in an open economy', *Journal of International Economics*, **19**, 67-84.

Phelps, E.S. (1961). 'The golden rule of accumulation: A fable for growthmen', *American Economic Review*, **51**, 638-43.

Sen, P. (1996). 'Dynamic efficiency in a two-sector overlapping generations model', Working Paper No. 38, Centre for Development Economics, Delhi School of Economics.

Shell, K. (1971). 'Notes on the economics of infinity', *Journal of Political Economy*, **79**, 1002-11.

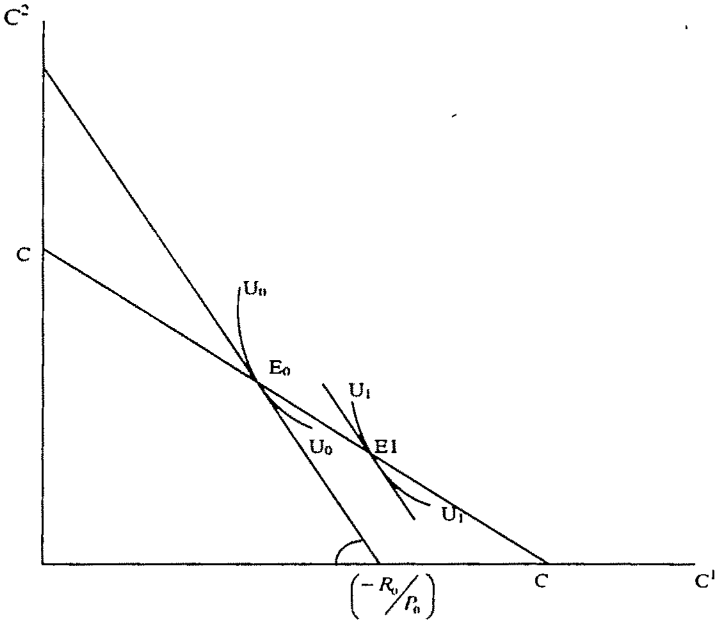

Figure : 1

Prabal & Indrani / Arthaniti 10 (1-2), I-II / 2011 /16

Mixed Duopoly with Price Competition

Prabal Roy Chowdhury*
(Indian Statistical Institute)
&
Indrani Roy Chowdhury*
(Jamia Milia Islamia University)

ABSTRACT

The Paper examines a mixed duopoly with price competition where the public firm meets all the demand coming to it. If the private firm is free to supply less than demand then there is *unique* Nash, as well as coalition-proof Nash equilibrium (CPNE), where both firms charge the *competitive price*, involving positive profits for the public firm and no allocative inefficiency. However if both firms have to meet all demand coming to them, then the Nash equilibrium prices can be either higher or lower compared to the case where the private firm is free to supply less than demand, but the CPNE prices are higher. Further, irrespective of market structure, privatization is not welfare increasing in general.

JEL Classification: L1, L2, L3.

Keywords: Mixed duopoly; coalition-proof Nash equilibrium; privatization, welfare maximizing outcome; price competition.

---

*Indian Statistical Institute, Delhi Center,
7 S J S Sansanwal Marg, New Delhi 110016, India.
Phone : +91-11-4149 3930
Fax : +91-11-4149 3981
E-mail : prabalrcl@gmail.com
** Department of Economics
Jamia Milia Islamia University
New Delhi - 110007
e-mail : indranirc@gmail.com

1. Introduction

This paper examines a mixed duopoly with price competition, focusing on some aspects that arise naturally in this framework, in particular that the public firm supplies all the demand coming to it. Further, we allow for the possibility of limited collusion among the fims, identifying market structure where such collusion may, or may not make a difference.

If the private firm is free to supply less than demand, we find that there is a unique Nash, as well as coalition-proof Nash equilibrium (henceforth CPNE), where both firms charge the competitive price. Whereas if both firms have to meet all the demand coming to them, then the Nash equilibrium prices can be either higher, or lower compared to the case where the private firm is free to supply less than demand. Moreover, all equilibria are symmetric, so there is no allocative inefficiency arising out of differential pricing and involve non-negative profits for the private firm. Further, irrespective of market structure, privatization is not welfare increasing in general.

The assumption that firms supply all demand dates back to Chamberlin (1933) and is natural whenever costs of turing away customers are high. In case of Public firms such costs may of course arise out of governmental concerns that some consumers may remain unserved. Vives (1999) for example mentions that in regulated industries like electricity, or telephone, regulations that firms supply all demand are in force in the USA.[1] Spulber (1989) argues that the common carrier regulation can lead to a scenario where firms supply all demand.[2] While the literature mostly explores this formulation (i.e., firms supplying all demand) in the context of private firms,[3] there is relatively little work in the context of mixed oligopoly.[4] This paper makes a beginning in this respect.

---

[1] In the Indian context for example, public banks, as well as public telephone services have an obligation to supply rural consumers

[2] Such costs may arise even in the absence of governmental regulations, eg in the presence of reputational costs of turning customers away, and are routinely assumed in the operations research literature (see, Taha (1982).

[3] See, among others, Vives (1999), Roy Chowdhury and Sengupta (2004) etc

[4] A notable exception is Ogawa and Kato (2006) discussed later.

We examine two forms of competition, one where the private firm also has to supply all demand, and another where the private firm is under no such obligation. For ease of reference, we shall call these the Bertrand, and the semi-Bertrand form of price competition respectively. The first framework is natural if, for example, the government is concerned with maintaining a level playing field. In the absence of such concerns however, such an assumption may be less compelling. We therefore consider both these frameworks.

Moreover, we allow for the possibility that there may, or may not be limited cooperation among the two firms. In the presence of limited cooperation we focus on equilibria that are immune to group deviations, formally we adopt the coalition-proof Nash equilibrium (CPNE), introduced in Bernheim et al. (1987) and Bernheim and Whinston (1987)[5,6], We show that while the possibility of limited collusion does not affect the equilibrium outcome in case of semi-Bertrand competition, it yields a sharper prediction under Bertrand competition. Further, under Bertrand competition, the effects of privatization is critically dependent on whether there is limited collusion or not.

Under semi-Bertrand competition, we demonstrate that there is a unique Nash, as well CPNE that involves both firms charging the first-best, i.e. the competitive price. Moreover, in this equilibrium all firms earn strictly positive profits. The result arises from an interplay of two factors, first that the private firm is free to supply less than demand, and second, that the public firm has to supply all demand. For any price higher than the competitive price, both firms are demand constrained, so that the private firm has an incentive to undercut so as to increase quantity sold. On the

---

[5] Such coordination may be facilitated by the government and its regulatory agencies. In the Indian telecommunications industry for example, private firms, e.g Bharti-Airtel, etc. compete with government firms like VSNL and MTNL The industry is regulated by the governmental regulatory authority, TRAI, which coordinates among the various players, keeping an eye on various policies followed by the firms Further, these firms may regularly interact in various professional bodies, e g. FICCI, ASSOCHAM, etc , that act on behalf of private firms.

[6] While a formal definition of CPNE is provided later, recall that unlike the collusive outcome, a CPNE must be immune to individual deviations, and unlike a Nash equilibrium, it must be immune to 'reasonable' group deviations.

other hand, if price is less than the competitive price, then the private firm only supplies till its marginal cost, leaving the public firm to supply the rest. With convex costs however, this is too costly, so that increasing prices is optimal for the public firm even after taking the consumers' surplus into account.

Clearly, these results suggest that privatization cannot be welfare inproving. In fact, we find that the first best outcome cannot be supported as a Nash equilibrium under privatization.[7] These result have several other interesting implications. First, these corroborate the intuition, develouped, among others, by Anderson et al. (1997) and Cremer et. al. (1989, 1991), that public firms play a role in controlling high prices. In fact, the results here are even stronger in that under semi-Bertrand competition, the first best is implemented as the unique equilibrium.[8] Second, as in Anderson et al. (1997) and Ogawa and Kato (2006), the public firm makes a positive profit, showing that welfare maximization is not inconsistent with making a profit. Third, we find that the equilibria are symmetric. This is in line with Ogawa and Kato (2006) but different from Anderson et al. (1997)who find that the public firm charges a relatively lower price compared to the private firms. This shows that the allocative inefficiency effect under price competition uncovered by Anderson et al. (1997) is not present when the products are homogeneous and the public firm must supply all demand. Finally, given that a CPNE fails to exist in many games,[9] the existence result (as well uniqueness result under semi-Bertrand competition), is of independent theoretical interest.

Under Bertrand competition, the set of Nash equilibrium prices is an interval. We find that equilibrium prices can be both higher, as well as lower than that under semi-Bertrand competition. We then characterize the set of CPNE prices, demonostrating that it yields sharper predictions compared to Nash equilibrium. The set of CPNE prices is an interval, with prices ranging from the welfare maximizing one, to the price under complete privatization. This immediately implies that privatization is welfare reducing whenever there is limited collusion among the firms.

---

[7] In fact, the Edgeworth paradox holds in that no pure strategy equilibrium exists even though theh public firm supplies all demand

[8] An immediate implication is that unlike in the case under quantity competition, implementing the first best does not require a uniform subsidy. See, among others, white (1996), Poyago-Theotoky (2001), Myles (2002), Fjell and Heywood (2002), Tomaru (2006) and Kato and Tomaru (2007).

[9] See. e.g. Bernhem et al. (1987) and Bernheim and Whinston (1987).

Summarizing, the central message of the paper seems to be that irrespective of whether the private firm has to supply all the demand coming to it or not, privatization is not welfare improving in general.[10] The general tenor of the results are in line with Anderson et al. (1997) who demonstrate the importance of entry decisions and the consumers' love for variety, showing that privatization is welfare reducing in many cases (discussed later). In a similar vein Cremer et al. (1991) also show that with product differentiation, the impact of a public firms is ambiguous. While nationaloization leads to the first best with two firms, with triopoly privatization leads to higher welfare. As is well known from De Fraja and Delbono (1989) however, under certain conditions privatization may be welfare improving under Cournot competition. This is because the public firm has an incentive to produce too much (since it is concerned with consumers' surplus), thus creating an allocative inefficiency.

Given the importance of this market form there is a large and growing literature on mixed oligopoly. The early work of Merrill and Schneider (1966) has been followed by, among others, Cremer et al. (1989, 1991), De Fraja and Delbono (1989) and Anderson et al. (1997), focusing, among other issues, on the effects of privatization on welfare.[11] We refer the readers to De Fraja and Delbono (1990) for a succinct survey of the early literature.

---

[10] The only time privatization can be welfare improving is under Bertrand competition when there is no collusion among the firms, and even then the set of Nash equilibrium prices is the same with, or without privatization.

[11] While the earlier literature mostly deals with the issue of full socialization versus full privatization, Matsumura (1998), Matsumura and Kanda (2005), Chao and Yu (2006), Fujiwara (2007) and Roy Chowdhury (2009), among others, examine the case of partial privatization. Another branch of the literature deals with the so called irrelevance principle, see, e.g. White (1996), Poyago-Theotoky (2001), Myles (2002), Fjell and Heywood (2004), Tomaru (2006), Kato and Tomaru (2007) and Roy Chowdhury (2009). Further, while many of these papers deal with domestic firms, Fjell and Pal (1996), Pal and White (1998), Fjell and Heywood (2002), Matsumura (2003) and Matsushima and Matsumura (2006), among others, examine mixed oligopoly with foreign firms.

The papers closest to ours are Anderson et al. (1997) , Cremer et al. (1991) and Ogawa and Kato (2006) . In the context of price competition with differentiated products, Anderson et al. (1997) demonstrate that in the short run, privatization is harmful since disciplinary role of the public firm is lost. Further, privatization can be welfare reducing even in the long run if the public firm is profit-making. Cremer et al. (1991) also analyze a mixed price oligopoly with endogenous location choice. They find that privatization is welfare reducing under duopoly, or when the number of private firms is at least five. Comparing these results with the present paper, we also find that in general privatization is not welfare improving. In fact, the present paper goes further and shows that the first best can be uniquely implemented under the semi-Bertrand framework. Further, the present paper differs from these two in that we analyze price competition with homogeneous, rather than differentiated products, focusing on the implications of the Bertrand assumption for the public firm, as well as the possibility of limited collusion among the firms. Our analysis shows that with homogeneous products, the results under price competition critically depend on both these aspects.

Ogawa and Kato (2006) was the first paper to examine a framework with price competition where the public firm must supply all demand coming to it. In fact our results demonstrate that Proposition 1 in Ogawa and Kato (2006) is robust to general demand and cost functions. The present paper however differs from Ogawa and Kato (2006) in several respects. First, Ogawa and Kato (2006) focus on Bertrand competition, whereas we examine both the Bertrand and the semi-Bertrand frameworks. Second, unlike Ogawa and Kato (2006), we also examine partial collusion among firms, showing that partial collusion leads to sharper predictions under the Bertrand model.[12]

The next section sets up the model and derives some preliminary results.

---

[12] Ghosh and Mitra (2009) compares the Bertrand and the Cournot mixed oligopoly with heterogenous products.

G165656

Section 3 solves for thr both Nash, as well as coalition-proof equilibria under semi-Bertrand competition, while Section 4 solves for the Bertrand case. Section 5 concludes. Finally some of the proofs are given in the Appendix.

2 The Model

There is one public and one private firm, firm 1 and firm 2 respectively, both producing a homogeneous good. The private firm is a profit maximizer, whereas the public firm maximizes social welfare.

The output of the i-th firm is denoted q_i, with both firms producing a homegeneous product with a demand function $D(p)$, and the cost function of both firms are denoted by $c(q)$. The following two assumptions on $D(p)$ and $c(q)$ are maintained throughout the analysis.

A1 : $D : [0, \infty) \to [0, \infty)$. $D(p)$ is twice differentiable and strickly decreasing for all p such that such that $D(p) > 0$. There exists a choke-off price K such that $D(p) > 0$ if and only $p < K$.

A2 : $c : [0, \infty) \to [0, \infty)$. $c(q)$ is twice differentiable, strictly increasing and strictly convex for all $q > 0$. Further, $c'(0) = 0$.

The firms simultaneously announce their prices. The public firm supplies the whole of the demand coming to it at that price vector. Under Bertrand competition the private firm also supplies all demand, while under semi-Bertrand competition the private firm is free to supply less than the quantity demanded. Let p_i denote the price charged by firm i.

We need some notations and preliminary results.

2.1. Bertrand Competition

The Model here generalizes that in Ogawa and Kato (2006) in that it allows for more general demand and cost functions. Letting $D_i(p_1, p_2)$ denote the residual demand facing firm i under Bertrand competition.

$$D_i(p_1,p_2)=\begin{cases} 0, & if\ \mathrm{pi} > \mathrm{pj}, \\ \dfrac{D(p_i)}{2} & \text{if pi} = \text{pj} \\ D(p_i), & \text{if pi} < \text{pj} \end{cases}$$

Thus the profit of the *i*-th firm under Bertrand competition is

$$\pi_i(p_1,p_2)=p_iD_i(p_1,p_2)-c(D_i(p_1,p_2)),\ i=1,\ 2, \tag{1}$$

and letting p = min $\{p_1, p_2\}$, the aggregate welfare under Bertrand competition

$$W(p_1,p_2)=\pi_1(p_1+p_2)+\pi_2(p_1+p_2)+\int_0^{D(p)} D^{-1}(q)dq-pD(p). \tag{2}$$

Thus firm 1 (the public firm) maximizes welfare, i.e. $W(p_1, p_2)$. whereas the private firm maximizes profit i.e. $\pi_2(p_1,p_2)$. We solve for the pure strategy Nash as well as coalition-proof Nash equilibrium in prices.

Definition 1. A price vector (p_1, p_2) constitutes a Nash equilibrium if and only if $W(p_1,p_2) \geq W(p_1',p_2)\forall p_1',\ and\ \pi_2(p_1,p_2) \geq \pi_2(p_1,p_2')\forall p_2'$.. Let Γ be the set of Nash equilibrium price vectors.

Definition 2. A price vector $(p_1, p_2) \in \Gamma$ constitutes a coalition-proof Nash equilibrium (CPNE) if and only if there exists no other $(p_1',p_2') \in \Gamma$ such that $W(p_1',p_2') > W(p_1,p_2)\ and\ \pi_2(p_1',p_2') > \pi_2(p_1,p_2)$.

It is important to note that a CPNE is different from the collusive outcome since a CPNE must also be a Nash equilibrium, i.e. it must be proof to deviations by individual firms.

Next let $\overline{W}(p)$ denote the welfare when both firms charge the same price p, whereas $\underline{W}(p)$ denotes the social welfare when one of the firms charge a price p that is strictly lower than that charged by the other firm. Formally

$$\overline{W}(p) = W(p_1, p_2)\Big|_{p_1 = p_2 = p,}$$

$$\underline{W}(p) = W(p_1, p_2)\Big|_{p_i = p < p_j} \qquad (3)$$

From the convexity of $c(q)$it is easy to see that $\overline{W}(p) = \underline{W}(p)$, $\forall p < \mathrm{K}$.

Similarly, $\overline{\pi}(p)$ denote the profit of both the firms when they both charge the same price p, whereas $\underline{\pi}(p)$denotes the profit of a firm that charges a price p that is strictly lower than that charged by the other firm. Formally

$$\overline{\pi}(p) \;=\; \pi_i(p_1, p_2)\Big|_{p_1 = p_2 = p,}$$

$$\underline{\pi}(p) \;=\; \pi_i(p_1, p_2)\Big|_{p_i = p < p_j.} \qquad (4)$$

We need another assumption.

A3: $\overline{\pi}(p), \underline{\pi}(p), \overline{W}(p)$ and $\underline{W}(p)$ are all strictly quasi-concave in p.

Remark 1 *Note that A3 is satisfied for linear demand quadratic cost functions. Further, A3 implies that for* $\overline{\pi}(p)$, $\underline{\pi}(p)$, $\overline{W}(p)$ *and* $\underline{W}(p)$ *the miniimizing price is unique whenever it exists. Further, these functions are all monotonic to the left and to the right of the respective maximizing prices.*

Let p^C *denote the competitive price that maximizes* $\overline{W}(p)$. *Clearly,* p^c *satisfies*

$$p = c'\left(\frac{D(p)}{2}\right) \qquad (5)$$

Moreover, let $\hat{p} = \arg\max \overline{\pi}(p)$, so that $\hat{p}$ solves

$$p = c'\left(\frac{D(p)}{2}\right) - \frac{D(p)}{D'(p)} \qquad (6)$$

In Lemmas 1 and 2 below we develop some preliminary results that we shall need for our subsequent analysis. The proofs of all the lemmas are provided in the appendix.

Lemma 1 Let A1-A3 hold. (i) $(i)\ p^C < \hat{p}$

(ii) $\overline{\pi}(p^c) > 0$

(iii) $\overline{\pi}(p^c) > \underline{\pi}(p), \forall p \leq p^c$

(iv) $\overline{\pi}(0) > \underline{\pi}(0)$

We then have

Lemma *2 Let A1-A3 hold. At any p < K solving* $\overline{\pi}(p) = \underline{\pi}(p)$ *both* $\underline{\pi}(p)$ *and* $\underline{W}(p)$ *are increasing in p.*

Note that any such *p* solves

$$p = \frac{c(D(p)) - c(D(p)/2)}{D(p)/2} \qquad (7)$$

Next define $\overline{p}$ to be maximal $p <$ K, such that $\overline{\pi}(p) = \underline{\pi}(p)$.

Note that A4 below is satisfied with linear demands and quadratic cost functions.

A4: $\overline{\pi}(p)$ and $\underline{\pi}(p)$ are strictly concave in *p*.

We need one more lemma.

Lemma 3 *Given A1-A4, (i) there is a unique price* $\overline{p} < K$ *such that*

$\overline{\pi}(\overline{p}) > \underline{\pi}(\underline{p}) > 0$, (ii) $\overline{\pi}(p) > \underline{\pi}(p) > \mathit{for}\, p < \underline{p}$, and $\overline{\pi}(p) < \underline{\pi}(p)\, \mathit{for}\, K > p > \underline{p}$,

and (iii) $p^c < \overline{p}$.

***Remark** 2 Note that Remark 1, and Lemmas 2 and 3(iii) together imply that* $\underline{W}(p)$ *and* $\underline{\pi}(p)$ *are increasing in p,* $\forall p \leq \overline{p}$

2.2. Semi-Bertrand Competition

Let the residual demand facing firm i under semi-Bertrand competition be denoted by $D_i'(p_1, p_2)$. Given that the public firm meets all demand, the residual demand facing the private firm takes the same form as that under Bertrand competition, so that $D_2'(p_1, p_2) = D_2(p_1, p_2)$. The residual demand for the public firm however will change form given that the private firm will supply min $\{D_2'(p_1, p_2), c'^{-1}(p_2)\}$ Thus assuming that the residual demand facing firm 1 is parallel in nature

$$D_1'(p_1, p_2) = \begin{cases} D(p_1), & \text{if } p_1 < p_2, \\ D(p_1) - min\{\dfrac{D(p_1)}{2}, c'^{-1}(p_1)\}, & \text{if } p_1 = p_2, \\ max\{D(p_1) - min\{D(p_2), c'^{-1}(p_2)\}, 0\}, & \text{if } p_1 > p_2, \end{cases}$$

Thus the profit function under semi-Bertrand competition is

$$\pi_i'(p_1, p_2) = p_i D_i'(p_1, p_2) - c(D_i'(p_1, p_2)),\ i = 1,2. \qquad (8)$$

Next let $CS(p_1, p_2)$ denote the consumers' surplus.[13] Then the aggregate welfare

$$W'(p_1, p_2) = \pi_1'(p_1, p_2) + \pi_2'(p_1, p_2) + CS(p_1, p_2) \ , \quad (9)$$

Thus firm 1 maximizes $W'(p_1, p_2)$, whereas the private firm maximizes $\pi_2'(p_1, p_2)$. The CPNE for this case can be defined, with appropriate modifications, in a manner analogous to that for the Bertrand case.

---

[13] Thus for

$p_1 \leq p_2, \mathrm{CS}(p_1, p_2) = \int_0^{D(p_1)} D^{-1}(q)dq - p_1 D(p_1)$. For $p_1 > p_2, \mathrm{CS}(p_1, p_2) =$

$\int_0^{\max\{D(p_1) - \min\{D(p_2), c'^{-1}(p_2)\}, 0\} + \min\{D(p_2), c'^{-1}(p_2)\}} D^{-1}(q)dq - p_2 \min\{D(p_2), c'^{-1}(p_2)\} -$

$p_1 \max\{D(p_1) - \min\{D(p_2), c'^{-1}(p_2)\}, 0\}$

3. Semi-Bertrand `Competition

Consider the semi-Bertrand game so that the private firm is free to supply less than the qunaity demanded, but the public firm supplies all demand. We begin by showing that the competitive price is supported as the unique Nash, as well as CPNE price. Further, the competitive price cannot be sustained as an equilibrium under privatization.

We begin by solving for the Nash equilibrium.

Proposition 1 *Let A1-A3 hold. Under semi-Bertrand competition the unique Nash equilibrium involves both firms charging* p^C.

Proof. We begin by showing that any Nash equilibrium must involve both firms charging the same price. Suppose to the contrary there is an equilibrium where the lower priced firm charges a price p'''. If firm 2 is charging p''', then there are two cases to consider. First suppose firm 2 is meeting the whole of the demand at this price. Let firm 1 deviate and match this price p''', when aggregate costs fall, since costs are convex and the total output $D(p''')$ is now shared between two firms. Since market price remains the same, consumers' surplus is unaltered, so that welfare goes up. Next suppose firm 2 was not meeting the whole of the demand, so that it was supplying till its marginal cost. Then firm 2 can increase its price slighly and still supply till marginal cost, when its profit increase. Whereas if firm 1 is charging p''', then note that firm 2 has no demand and hence zero profits. Let firm 2 deviate and match this price p'''. Note that if firm 2's output q_2 is small enough, then $p''' > c'(q_2)$ (since $c'(0) = 0$), so that firm 2 makes a strictly positive profit.

We then argue that no price $p > p^C$, can be sustained as a Nash equilibrium. Suppose to the contrary such an equilibrium exists. Since $p > p^C$ both firms must be demand constrained at such an equilibrium. But then firm 2 can undercut slightly to $p - \epsilon$, $\epsilon > 0$, and supply till its marginal costs. For ϵ small enough, its profit increases since the gain from undercutting (i.e. being able to supply till its marginal cost), outweighs the loss from a lower price.

Next cosider some $p < p^C$, so that firm 2 supplies till its marginal cost, and firm 1 meets the residual demand. Let firm 1 deviate by charging a higher price $p_l > p$. Note that welfare is given by (9). Differentiating (9) we obtain

$$\frac{\partial W'(p_1, p)}{\partial p_1} = D'(p_1)[p_1 - c'(D(p_1 - c'^{-1}(p)))].$$

Note that p_l close to p, $p_l < c'^{-1}(p)$ so that firm 1 has an incentive to increase its price from p, when welfare increases. ■

The fact that there is unique Nash equilibrium is interesting, given that Vives (1999) finds that the set of Nash equilibrium prices constitute an interval when both firms are profit maximizing and must supply all demand. Further, in contrast to the results under Cournot competition, the equilibrium price is not higher than the competitive price. The intuition follows from the fact that since the private firm has no obligation to supply all demand, undercutting is attractive for this firm. This prevents prices from becoming too high. Whereas if prices are lower than the competitive price, then the public firm has to supply a larger amount, thus pushing up costs. Thus in this case the public firm has an incentive to deviate to a higher price, so that it does not supply too much.

3.1 Coalition-proof Nash Equilibrium

We then turn to solving for the CPNE of this game. Given that there is a unique Nash equilibrium, the unique CPNE also yields the competitive price. This shows that limited collusion among firms does not affect the equilibrium outcome under semi-Bertrand competition.

Propostion 2 *Let A1-A3 hold. Under semi-Bertrand competition, the unique CPNE involves both firms charging the welfare maximizing price* p^C.

The existence and uniqueness of a CPNE for the semi-Bertrand game is of interest given that Bernheim et al. (1987) and Berheim and Whinston

(1987) show that a CPNE may fail to exist in many games.

In a series of remaks below, we check for the roubustness of Proposition 2, as well discuss possible extensions.

Remarks 3 *Note that the first two paragraphs in the proof of Proposition 1 do not depend on the fact that the residual demand facing firm 1 is parallel, and thus go through in case the residual demand function is proportional as well. While the last paragraph of the proof does use the property that the residual demand is parallel, an exactly analogous argument goes through for the proportional residual demand function.*

Remark 4 *We then argue that the competitive price continues to be the unique outcome even under a sequential move game where the public firm is the price leader. Note that if the public firm charges p^C, then the private firm's optimal response is to change P^C as well (follows from the proof of Proposition 1). Both firms charging P^C therefore constitues the unique subgame perfect Nash equilibrium of this game.* [14]

Remark 5 *Suppose that the cost functions are asymmetric, with $c^i(q)$ being the cost fucntion of the i-th firm. Suppose that the cost fucntions are not too dissimilar in the sense that there is a unique welfare maximizing price p^C that involves both the firms being active. Mimicing the argument for Proposition 1,it is straightforward to show that both firms charging p^C is a CPNE of this game. Whether other, possibly asymemtric CPNE exist is an open question.*

3.2 Privatization

We then examine the effects of privatizing the public firm when it has to supply the whole of the demand coming to it. From Propositions 1 and 2, it is clear that privatization can never be welfare improving. In fact Proposition 3 below shows that the competitive price cannot be implemented as a Nash equilibrium when the public firm is privatized, so that

---

[14] From preliminary analysis not reported here, we conjecture that the unique subgame perfect equilibrium when firm 2 is the price leader. involves both firms charging $\hat{p}$. One sufficient condition when this holds is that $D(\hat{p}) < c'^{-1}(\hat{p})$.

CALCUTTA CENTRAL LIBRARY

privatization is welfare reducing.

Proposition 3 *Let firm 1 maximize its profits, but continue to meet the whole of the demand coming to it. Under A1-A3, the competitive price p^C cannot be sustained as a Nash equilibrium.*

Proof. We examine if the competitive price p^C can be sustained as a Nash equilibrium. Let firm 1 deviate and charge a higher price p_1. Note that firm 1's profit is given by (8), so that differentiating (8)

$$\frac{\partial \pi_1'(p_1, p^C)}{\partial p_1} = D(p_1) + D'(p_1)[p_1 - c'(D(p_1) - c'^{-1}(p^C))].$$

For p_1 close $p^C, p_1 < c'(D(p_1) - c'^{-1}(p^C))$, so that firm 1 has an incentive to increase its price from p^C when its profit increases.■

Remark 6 *In fact, it is straightforward to show that no pure strategy equilibrium exists. We can mimic the argument in Proposition 1 to show that any equilibrium must involve both the firms being active and that no price greater than p^C is sustainable. Next the argument showing that p^C is not sustainable, also shows that any price $p < p^C$ is not sustainable. This is a variation of the well known Edgeworth paradox. It is interesting that the Edgeworth paradox holds even when one of the firms is constrained to supply all demand.*

Propositions 1, 2 and 3 together suggest that privatization cannot be welfare improving under semi-Bertrad competition. Recall that this is in line with Anderson et al. (1997) and Cremer et al. (1991).

4. Bertrand Competition

We next consider the case where both firms must meet all demand coming to them. This is of interest if, for example, the government insists on maintaing a level playing field for all firms. Interestingly, the Nash price under Bertrand competition can be either higher, or lower than the Nash equilibrium price under semi-Bertrand competition. However the CPNE price is 'higher' than that under semi-Bertrand competition. Further, in the presence of limited collusion privatization is welfare reducing.

Turing to the set of *Nash equilibrium* prices, Ogawa and Kato (2006) have already characterized the set of Nash equilibrium prices under Bertrand competition. Given that they focus on linear demand and quadratic costs though, it is of interest to examine if their results extend to more general demand and cost functions. Proposition 4 below demonstrates that this is indeed the case.

To this end let $\tilde{p}$ denote the minimal $p < K$ satisfying, $\overline{\pi}(p) = 0$ Clearly, $\tilde{p} > 0$.

Proposition 4 *Given A1-A4, any price $p \in [\tilde{p}, \bar{p}]$ can be sustained as a Nash equilibrium of the Bertrand game, with both firms charging the price p.*

While we omit a formal proof since it essentially generalizes that in Ogawa and Kato (2006), the argument is simple stated. For any $p > \bar{p}$ firm 2 will undercut, whereas for any $p < \tilde{p}$ firm 2 makes a loss. For any price in the stated range however, firm 2 does not undercut as $\overline{\pi}(p) \geq \underline{\pi}(p)$, and $\underline{\pi}(p)$ is increasing over this range. Similarly, firm 1 does not undercut as $\overline{W}(p) > \underline{W}(p)$ and $\underline{W}(p)$ is increasing over this range.

Next note that $\tilde{p} < p^C < \bar{p}$. Thus a comparison of Propositions 1 and 4 show that the Nash price under Bertrand competition can be either higher, or lower than that under semi-Bertrand competition. This is interesting since it may appear that under the semi-Bertrand form, competition is more severe (with the private firm having no obligation to supply all demand). The intuition as to why a lower price, say $p < p^C$, is sustainable under Bertrand competition is as follows. In this case the private firm will supply all the demand coming to it, so that if the public firm charges a higher price then there is a consequent drop in welfare to $\underline{W}(p) < \overline{W}(p)$.

4.1 Coalition-proof Nash Equilibria

In the next three propositions we characterize the set of prices that can be sustained as CPNE under Bertrand competition. We demonstrate that while the welfare maximizing price turns out to be a CPNE, there are other equilibria that involve higher prices. In particular the price under complete privatization turns out to be an equilibrium. Further, under an additional technical assumption, the set of CPNE prices also turns out to be an interval, ranging from all prices in between the competitive price and the price under mixed strategy equilibrium.

To begin with we can mimic the arugument in Propositions 1 and 2 to show that the competitive price can be sustained as a CPNE.[15]

Propostion 5 *Let A1-A3 be satisfied. Under Bertrand competition, the welfare maximizing price* p^C *can be sustained as a CPNE with both firms chargung* p^C.

Roy Chowdhury and Sengupta (2004) demonstrate that the unique CPNE outcome under complete privatization (where both firms maximize profits) involves both firms charging a price of min $\{\hat{p},\bar{p}\}$. Note that min $\{\hat{p},\bar{p}\} > p^C$. Somewhat suprisingly, it turns out that this price can be sustained as a CPNE of the Bertrand mixed duopoly game.

Proposition 6 *Let A1-A3 be satisfied. Under Bertrand competition, min* $\{\hat{p},\bar{p}\}$ *(the price under complete privatization) can be sustained as a CPNE with both firms charging min* $\{\hat{p},\bar{p}\}$

Proof. We first argue that no profitable joint deviation exists that is proof to individual deviations. If $\hat{p} \leq \bar{p}$, then there is nothing to prove. So let $\bar{p} < \hat{p}$. Then for any decrease in price $\bar{\pi}(p)$ falls, whereas for an increase in price $\overline{W}(p)$ decreases. We then examine if there can be profitable individual deviatioins. Consider the public firm. By Lemma 2, $\underline{W}(p)$ is increasing to the left of $\bar{p}$ and moreover $\overline{W}(p) > \underline{W}(p)$, so undercutting is welfare reducing. Next consider the private firm. Since $p \leq min\{\bar{p}, \hat{p}\}, \bar{\pi}(p) \geq \underline{\pi}(p)$ Thus by Lemma 2, undercutting is not profitable for firm 2.■

---

[15] The argument that the private firm has no incentive to undercut follows from Lemma1 (iii) for thid case.

We next argue that under an additioinal assumption A4, all prices $p \in (p^C, min\{\bar{p}, \hat{p}\})$ can be sustained as a CPNE. Further, no other CPNE exists.

Proposition 7 *Let A1-A4 hold. Any price $p \in (p^C, min\{\bar{p}, \hat{p}\})$ can be sustained as a CPNE. Further, no price less than p^C, or greater than $min\{\bar{p}, \hat{p}\}$ can be sustained.*

Proof. Note that for any $p \in (p^C, min\{\bar{p}, \hat{p}\})$ no profitable joint deviation exists. By Lemma 2, the public firm does not have a profitable individual deviation. Thus for any such *p* to be sustained as a CPNE, it is sufficient to rule out undercutting by the private firm. This follows since from Lemma 3, $\bar{\pi}$(p) and $\underline{\pi}$(p) has a unique intersection at $\bar{p}$.

We then argue that no other price can be sustained as a CPNE.Consider an outcome where the active firm charges a price less than p^C. Then a joint deviation to p^C clearly increase welfare. Further, firm 2's profit increases as $\hat{p} > p^C$ and $\bar{\pi}(p)$ is increasing for $p < p^C$. Further, this joint deviation to p^C is proof to individual deviations.

Next consider an outcome where the active firm charges $p > \bar{p}$. If both firms are active, then firm 2 can undercut and gain. So let only one firm be active. If firm 1 is the active firm, it can reduce price, when welfare increases. when welfare increases. Whereas if firm 2 is the active firm, then firm 1 can match this price, when welfare increases. So let $\hat{p} < p \leq \bar{p}$. Then a joint deviation to $\hat{p}$ benefits both firms (for firm 1 welfare increases since $p^C < \hat{p}$) and is proof to individual deviations.■

Note that we obtain a sharper prediction under CPNE compared to that under Nash equilibrium. Even under CPNE however prices higher than the competitive price cannot be ruled out.

4.2 Privatization

We next turn to the effects if privatization in the Bertrand framwork. From Roy Chowdhury and Sengupta (2004), we know that the unique CPNE price when both firms are profit-maximizing is min $\{\bar{p}, \hat{p}\}$, which corresponds to the maximal CPNE prices when firm 1 is welfare maximizing. Further, it is simple to mimic Proposition 4 to show that the set of Nash equilibrium price when both firms are profit-maximizing is $[\tilde{p}, \bar{p}]$, i.e. the same as with a welfare maximizing firm 1.

We, thus find that under Bertrand competition with limited collusion, privatization reduces welfare. In the absence of collusion however, the set of Nash equilibrium prices is not affected by privatization. Thus the results in the Bertrand case also corroborate those in Anderson et al. (1997) and Cremer et al. (1991).

5. Conclusion

This paper extends the mixed oligopoly literature with price competition by allowing for a public firm that supplies all demand, and limited collusion. Interestingly, we show that under semi-Bertrand competition there is a unique Nash, as well as CPNE that leads to the first best outcome, involving positive profits for the public firm and no allocative inefficiency. Moreover, our analysis has some implications for policy. First it shows that in general privatization is welfare reducing. Next consider the condition that the private firm must also meet the whole of the demand coming to it, which may be attractive from a fairness angle. Our analysis demonstrates however that doing so can be welfare reducing.

Finally, we mention some issued for further research. While we restrict attention to the duopoly case, preliminary analysis suggests that the results go through qualitatively if there is one public firm facing $n \geq 1$ private firms. Moreover, it would be of interest to allow for the case where the private firm is a foreign one, as well as the case where the public firm is partially privatized.

6. Appendix

Proof of Lemma 1. (i) follows from Eq. (5) and (6).

(ii) $\overline{\pi}(p^C) = \frac{D(p^C)}{2}[p^C - \frac{c(D(p^C)/2}{D(p^C)/2}] > \frac{D(p^C)}{2}[p^C - c'(D(p^C)/2)] = 0$,

where the first inequality follows since $c(q)$ is strictly convex and $D(p^C) > 0$.

(iii) Consider $p < p^C$. Then $D(p) > D(p)/2 > c'^{-1}(p)$, it follows that $\overline{\pi}(p) > \underline{\pi}(p)$.

Consequently,

$$\overline{\pi}(p^C) \geq \overline{\pi}(p) > \underline{\pi}(p),$$

where the first inequality follows from Lemma 1(i) and the fact that $\overline{\pi}(p)$ is increasing for $p \leq \hat{p}$.

(iv) Follows since $\overline{\pi}(0) = -c(\frac{D(0)}{2}) > -c(D(0)) = \underline{\pi}(0)$. ■

Proof of Lemma 2. Recall that any such p solves

$$p = \frac{c(D(p)) - c(D(p)/2)}{D(p)/2},$$

so, that from strict convexity of c(q) we have that $p < c'(D(p))$.

Consequently, note that at such a p,

$$\pi'(p) = D(p) + D'(p)[p - c'(D(p))] > 0,$$

and $\underline{W}'(p) = D'(p)[p - c'(D(p))] > 0,$

from the previous paragraph. ■

Proof of Lemma 3. (i) Given Lemma 2, $\underline{\pi}(p)$ is positively sloped at $p = \overline{p}$. Hence if there are multiple such intersections, then concavity of $\overline{\pi}(p)$ must be violated. Further, $\overline{\pi}(p) = \underline{\pi}(p) > 0$ since from Remark 1 $\pi(p)$ is monotonically decreasing for p such that $p^C \leq p \leq K$.

(ii) Follows since $\overline{\pi}(0) > \underline{\pi}(0)$ (Lemma 1 (iv)) and $\overline{p}$ is unique.

(iii) The fact $p^C < \overline{p}$ follows from (5) and (7). ■

7 References

Anderson, S. P., de Palma, A., Thisse J., 1997. Privatization and efficiency in a differeniated industry. European Economic Review 41, 1635-54.

Bernheim, B.D., Peleg, B., Whinston, M.D., 1987. Coalition-proof Nash equilibria I: Concepts. Journal of Economic Theory 42, 1-12.

Bernheim, B.D., Whinston, M.D., 1987. Coalition-proof Nash equilibria II: Applications. Journal of Economic Theory 42, 13-29.

Chamberlin, E.H., 1933. The Theory of Monopolistic Competition. Cambridge: Harvard University Press.

Chao, C., Yu, E. S. H., 2006. Partial privatization, foreign competition and optimum tariff. Review of International Economics 14, 87-92.

Cremer, H., Merchand, M., Thisse, J.F., 1991. Mixed oligopoly with differentiated products. International Journal of Industrial Organization 9, 43-53.

De Fraja, G., Delbono, F., 1989. Alternative strategies of a public enterprise in oligopoly. Oxford Economic Papers 41, 302-311.

De Fraja, G., Delbono, F., 1990. Game theoretic models of mixed oligopoly. Journal of Economic Surveys 4, 1-17.

Fjell, K., Heywood, J.S., 2002. Public Stackelberg leadership in a mixed oligopoly with foreign firms. Australian Economic Papers 41, 267-81.

Fjell, K., Heywood. J.S., 2004. Mixed oligopoly, subsidization and the order of firm's moves: the relevance of privatization. Economics Letters 83, 411-4116.

Fjell, K., Pal, D., 1996. A mixed oligopoly in the presence of foreign private firms. Canadian Journal of Economics 29, 737-743.

Fujiwara, K., 2007. Partial privatization in a differentiated mixed oligopoly. Journal of Economics 92, 51-65.

Ghosh, A., Mitra,M. 2008. Comparing Bertrand and Cournot outcomes in the presence of public firms. UNSW, School of Economics DP 2008/18

Kato, K.,Tomaru, Y., 2007. Mixed oligopoly, privatization, subsidization, and the order of firms' moves: several types of objectives. Economics Letters 96, 287-292.

Matsumura, T., 1998. Partial privatization in mixed duopoly. Journal of Public Economics 70, 473-483.

Matsumura, T., 2003. Stackelberg mixed duopoly with a foreign competitor. Bulletin of Economic Research 55, 275-287.

Matsumura, T., Kanda, O., 2005. Mixed oligopoly at free entry markets. Journal of Economics 84, 27-48.

Matsushima, N., Matsumura, T., 2006. Mixed oligopoly, foreign firms and location choie. Regional Science and Urban Economics 36, 753-72.

Merrill, W., Schneider, N. 1996. Government firms in oligopoly industries: a short run analysis. Quarterly Journal of Economics 80, 400-412.

Myles, G, 2002. Mixed oligopoly, subsidization and the order of firm's moves: an irreelevance result for the general case. Economics Bulletin 12, 1-6.

Ogawa, A., Kato, K., 2006. Price competition in a mixed duopoly. Economics Bulletin 12, 1-5.

Pal, D., White, M. D., 1998. Mixed oligopoly, privatization and strategic trade policy. Southern Economic Journal 65, 264-81.

Poyago-Theotoky, J., 2001. Mixed oligopoly, subsidization and the order of firm's moves: an irrelevance result. Economics Bulletin 12, 1-5.

Roy Chowdhury, P., Sengupta, K., 2004. Coalition-proof Bertrand equilibria. Economic Theory 24, 307-324.

Roy Chowdhury, P., 2009. Mixed oligopoly with distortions: first best with budget-balance and the irrelevance principle. Economics Bulletin 29. 1885-1900.

Spulber, D.F., 1989. Regulation and Markets. Cambridge, MA: The MIT Press.

Taha, H., 1982. Operations Research. Collier Macmillan.

Tomaru, Y., 2006. Mixed oligopoly, partial privatization and subsidization. Economics Bulletin 12, 1-6.

White, M., 1996. Mixed oligopoly, privatization and subsidization. Economics Letters 53, 189-195.

Vives X., 1999. Oligopoly Pricing: Old Ideas, New Tools. Cambridge MA London: The MIT Press.

Ajitava & Jayati / Arthaniti 10 (1-2), I-II / 2011 /38

Understanding Foreign Aid in an Endogenous Model of North-South Global Relations

Ajitava Raychaudhuri
Department of Economics, Jadavpur University, Kolkata 700032, India
E-mail: ajitava1@gmail.com
&
Jayati Bhattacharya
Department of Economics,
Vivekananda College for Women, Barisha. Kolkata 700008, India.
E-mail: bjayatiz@gmail.com

ABSTRACT

The contribution of developed countries in the growth and welfare of the developing countries has been subjected to numerous scrutinies. The developing countries, almost without exception, are going through a process of liberalization and reform of various degrees in the last two decades. However, the developed countries are suffering from the phenomenon of "aid fatigue". The most effective form of unrequited and soft loan transfer from the developed nations and international financial organizations to low and middle income nations need be analytically established. The present paper resurrects the old debate of transfer payments, terms of trade and welfare, but in a new framework. Basing on the data on the actual dynamics of growth in some crucial variables of developing countries, the analytical structure of the paper has brought to the forefront the importance of the economies of scale factor through variety of intermediate inputs (Romer type) along with the importance of human skill accumulation (Lucas type) in a North-South global interaction framework. The North has the R & D, and the South might benefit from them through trade in intermediate inputs that embodies the R & D. The result shows aid from the North (Developed world) distinctly improves the growth and welfare of the South (Developing world) despite falling terms of trade provided the aid is meant to facilitate adaptation of newer varieties of intermediate inputs. Any other form of aid may lead to the problem of fungibility, and may be wasted without any welfare or growth effects. Thus, the developed world can help the reforming developing world in pushing its agenda for a distortion free economic system by providing the right kind of aid instead of reducing the quantum of aid as a matter of policy.

JEL Classification : 011, 015, 019, 041, F35

Introduction:

Recent debates on restructuring global economic relations have centered around several major topics. One of them is the effectiveness of foreign aid in promoting growth and alleviating poverty in developing countries (Dalgaard, Hansen and Tarp, 2002; World Bank, 1998). Another is somewhat an old, but continuing one, namely what do developing nations gain if the terms of trade move continuously against them (UNCTAD, 2002; Maizels et al, 2000)? The third one revolves around the creation of WTO and its role in promoting a free trade regime in the world (Krugman and Obstfeld, 2000). Understandably, none of the above may be viewed in isolation – one topic has its own ramifications on another. However, most of the debates center around one topic at a time, with occasional references to the other. This may be suitably addressed by putting the issues as hypotheses in an integrated framework whose results will provide answers to these as natural outcomes. The present paper will make an effort to unravel the dynamic interrelation and interconnection among foreign aid, growth, terms of trade and welfare in an analytical framework. The main goal of the analysis is to understand the importance of foreign aid and the role of donors in invigorating the reform process in developing countries.

An Overview:

One may begin with some facts highlighted in almost every paper written on the topic of aid and its effectiveness. The first is that in a typical low-income economy, foreign aid as percentage of GNP was approximately 7-8 per cent, although the data reveal that in general, foreign aid neither did increase growth nor did it alleviate poverty or its associated features (Boone, 1996; Burnside and Dollar, 1997). However some studies have found that it had success in countries having good fiscal and monetary policies (Burnside and Dollar, 1997) or having good institutions (Svensson, 1999) or even having climate related advantages (Dalgaard, Hansen and Tarp, 2002). Easterly, Levine and Roodman (2003) disputed the findings of

Burnside and Dollar by extending their dataset. There seems to be some compulsions on the part of the bilateral donor agencies to disburse the fund as otherwise this does not prove "efficiency" on the part of the concerned departments (Svensson, 2003; Vasquez, 2002). One study gives the bleak picture that USA alone gave US $144 billion (in constant 1999 US dollars) in official development assistance to 97 less developed countries between 1980-2000, but the compound growth rate of per capita GDP for these countries averaged –0.16 per cent (in constant 1999 US dollars) with 12 experiencing negative growth and only four achieving growth over 1 per cent (Schaefer, 2003). As Drazen (1999) argues, foreign aid is ineffective when government misappropriates because of its political structure. He quotes Dollar and Svensson, who studied 179 World Bank projects over the period 1980-95, that conditionality fails once political variables are brought into the picture. On the question of "fungibility", that is diversion of foreign aid to different and possibly "unproductive' uses, one cross-country panel study found that only transport and communication sectors fulfill the intention of the donors (Devarajan et al, 1999). As one study comments on World Bank- "If something has to get the Bank's imprimatur, the expectation should be that there is a clear and well-understood theory behind it, and that it has been subjected to multiple randomized evaluations (italics ours)" (Banerjee and He, 2003). This paper is indeed a search for such an elusive theory.

It is interesting to note, one line of argument is that countries like South Korea or Taiwan succeeded only after US has cut off its massive aid (Vasquez, 2002). But then, the institutional and political structures of these countries could be singled out for this – which Bhagwati characterized as authoritarian governments with markets (CBO, 1999).

This characterization is important, but that does not really pinpoint what played the catalytic role in transforming the highly successful East Asian economies. After all, this is the traditional "Chicken and Egg" question – Do the countries succeed in its endeavour to grow, hence aid became redundant or they grew despite foreign aid, not because of it?

It is pertinent to note that there is an increasing concern in the developed countries to devise a "win-win" situation in case of giving foreign aid. As Rogoff (2003) argues, the aging bulge of population of developed countries need to use foreign aid as a kind of social security so that a prospering developing world opens up new vistas for international transactions with them. As Heyneman (2003) aptly sums up that taxpayer in USA should be able to comment with hindsight "we did a good job. We made the right choice". This is exactly the motivation of this paper too- to identify the catalysts of growth and "right role" for foreign aid.

The following tables summarise some of the stylized facts to understand the positions of the countries in the world map of growth and prosperity.

Table 1: Some Relevant Indicators of Development

Country/Region	*Annual percentage change of Real GDP (Base-1987)*		*ODA as percent of GNP*		*Percentage change in Manufacturing Terms of Trade with EU (NBTT)*
	1981-90	*1991-97*	*1991*	*1996*	*1979-94*
High Income	3.1	2.1	-	-	-
Developing	3.0	3.1	1.5	0.9	-2.2
East Asian	7.7	9.9	1.0	0.6	-1.2
Latin American	1.9	3.4	0.5	0.5	-3.6
South Asia	5.7	5.7	2.3	1.1	-
Sub-Saharan	1.9	2.2	6.3	5.3	-5.7

NOTE: ODA is Official Development Assistance; NBTT is Net Barter Terms of Trade

SOURCE:

1) Real GDP growth data from Global Economic Prospects, World Bank, 1998/99
2) ODA data from World Development Report, 1998/99
3) Manufacturing Terms of Trade (TOT) data from Maizels et al.(1998)

Table 2: The Global Economic Scenario

Country	*Illiteracy Rate (%)*		*Manufactures as per cent of total Exports*		*Share of Manufacturing and transport equipments*		*NBTT (1987= 100)*		*R & D (% of GNP)*	*Small Formal Sector Firms as (%) of Total*		*Total*
					In total Imports					*Firms*		*Output*
(1)	(2)		(3)		(4)		(5)		(6)	(7)		(8)
	'80	'99	'80	'96	'70	'93		'80	'96	'90	'95	
Argentina	5 6	3 3	23	30	31	49	123*	116+	-	0 38	-	-
Brazil	24 5	15 1	37	54	35	33	96	97+	-	0.84	-	-
India	59 0	43 5	59	74	23	14	71.5	96+	0 8	0.73	76 2#	13.4#
B'Desh	70 8	59.2	68	81+	-	13	148 4	94+	-	0 03	-	-
China	34.5	16 5	-	84	-	42	109*	101+	0 68	0.61	58.9w	5.2w
Hong Kong	14 5	6 7	91	92	17	33	100.7	100.2	-	-	97.8n	53.8n
Thailand	12 4	4 7	25	73	36	45	116.5	103+	0.18	0.13	97.1'	-
Malaysia	28.6	3.0	19	76	28	54	131 9	99+	-	0 24	84.0'	77 5'
Korea	7.1	2.4	90	92	30	34	84 7	89.5	1.9	2 6	98 5^{c}	-
Indonesia	30 7	13.7	2	51	40	42	145*90+		-0 07	98.7^{c}	28.4^{c}	
Kenya	43 7	18 5	12	18+	34	25	144.3109.6		- -	-	-	
Nigeria	67 1	33.0	0	3+	3	-	167*	99+	0 87p	-	-	-

NOTE: + = year 1993; * = year 1985; ☐= year 1987; # = year 1992 and manufacturing only; ◆= year 1991 and manufacturing only; ■ = year 1993; ✹= year 1997 and manufacturing only; ⊙= year 1995; SME is defined to have 50 employees or less

SOURCE: 1) Columns 3 and 5 from World Development Report, 1998/99

2) Column 6 from World Development Indicators, 2001

3) Columns 7 and 8 from APEC website, http:// www.actetsme.org

4) Column 4 from World Development Report, 1995

5) Column 2 from World Development Indicators, 2001

Although there are many alternative ways one may analyse the development dynamics, the present paper defines the scope of such an analysis in a particular domain. As shown in Table 1, although developing countries experienced negative terms of trade in manufacturing trade with European Union, they grew faster than the developed countries in the nineties and equally in the eighties. Among them, East Asia had the highest growth in spite of having a negative movement in terms of trade during 1979-94. On the other hand, Sub-Saharan Africa had the lowest growth and experienced negative movement in terms of trade of a high order. At the same time, East Asia was able to reduce the official development assistance by a significant amount, while Sub-Saharan Africa still depends heavily on aid. Perhaps this rekindles the old debate once again – does aid precede growth or vice-versa? Before going into an analytical discussion of the same, one may have a look at the country-wise data in Table 2. The important observations, which emerge from the table, are as follows:

(a) Manufacturing export dominates exports for most of the developing countries (disregarding the fact that some of them might have graduated to a higher level over time). East Asian countries had a remarkable growth in such exports, while Sub-Saharan African countries showed very slow movement in this regard.

(b) Imports of machinery and equipments as a percentage of total imports show a remarkable rise during 1970-1993 for East Asian countries and China, while they were really small in South Asian and Sub-Saharan African countries.

(c) R & D expenditure (representing domestic R & D activities) does not show any remarkable change in any of the developing countries (except perhaps Korea). Thus domestic R & D is not a strong point of developing countries.

(d) All developing countries show rapid stride in reducing illiteracy rate (of persons over 15 years of age), but again East Asia and China had left others way behind.

(e) All countries, for which the data are available, show significant presence of small and medium industries (SMEs). They remain the backbone of industrial production in most of the developing countries.

(f) Net Barter terms of trade (NBTT), for most of the countries, show either a fall or a lower value than the base in both the early eighties and the mid-nineties.

What is the main motive for choosing such a specific dataset? It is specifically designed to build up the basis of the analytical reasoning that follows. First, the phenomenon of falling terms of trade (TOT) in international trade, which Prebisch (1950), Singer (1950) and Lewis (1954) termed as the key to unfair trade and asymmetric welfare in the world, may not be ultimately so bad as it might appear. The major point is that the current world differs from Prebisch-Singer-Lewis world in one vital dimension – South (or developing countries) also now specializes in manufacturing as opposed to primary goods in many cases. Thus falling TOT and high growth may coexist together leading to the idea that welfare in the South may be improving through trade in spite of falling TOT.

Second, the countries having highest growth are seen having low foreign aid levels too. At the same time, the better performers are not the ones who devote higher GNP to domestic R & D activities. However, they are the ones who have a high proportion of their imports devoted to machinery and equipments imports from the North (or, the old developed countries like EU or USA).

Third, the same set of high performers is the ones who have reduced the illiteracy among adult population drastically.

The above description is the most appropriate one to put the emerging global dynamics in an endogenous growth framework. The main impetus comes from seminal works of Romer (1986, 1990), Lucas (1988), Grossman and Helpman (1990), among others. Before going into the specific model, which will clearly show the inter-relationship among types of aid, growth, terms of trade and welfare, one may mention the empirical background of such an analytical framework. This will also help one to understand the perspective of the data presented in Tables 1 and 2 above more succinctly.

The empirical search started with Easterly et al (1994) and Coe and Helpman (1995). Coe and Helpman showed that for developed countries, openness with countries having larger Research and Development (R & D) produce the maximum change of total factor productivity (TFP). Coe, Helpman and Hoffmaister (1995) extended it to developing country data and showed that they benefit from foreign (or North's) R & D as well as domestic skilled labour. Their findings did support the view that trade in intermediate products (which includes machineries and equipments), which embody the fruits of R & D, do promote growth in developing countries. One finds support of this hypothesis from data produced in Caselli and Wilson (2003), Schiff, Wang and Olarreaga (2002), Caselli and Coleman II (2001) and Keller (2001). Eaton and Kortum (2000) provided the data that R & D is mostly done in the North and is transmitted to the South through equipments trade (or intermediate input trade). Easterly (1998) sums it up aptly- "Development economists should shift their emphasis from increasing human and physical capital investment to increasing technology adaptation, from improving investment to improving policies". This is echoed later by Stiglitz (2002) too.

The above overview of theory and empiricism provide sufficient material to go for an analytical model that would try to answer the following questions:

(a) If the developed countries and their citizens want to make a right choice is giving aid to developing countries, what should be the type and category of aid?

(b) If the right type of aid is chosen, how does it promote growth and welfare in the southern countries?

(c) Does it throw additional lights on the terms of trade debate between the South and the North?

The model below will try to provide answer to each one of them and consequently, chart out the optimal role and responsibility of bilateral and multilateral aid agencies/donors.

The model:

The model below has drawn materials from Bhattacharya and Raychaudhuri (2004).

I. Basic assumptions

In our model, the North or the Developed World has the following stylized features.

1) There are three types of productive activities- a) production of designs (for intermediate goods) in an R&D sector, b) production of intermediate goods and c) production of final good;

2) All three sectors use only one primary factor – labour. The size of labour remains unchanged over time, and is fully employed.

3) Intermediate goods are partial substitutes of each other.

4) It exports intermediate goods as well as final good to the South. It imports the Southern final good.

On the other hand, the South or the Developing World has the following features.

1) It produces only a final good in a competitive framework, and uses some of the Northern intermediate goods and labour in the process.

2) The capacity to use the imported intermediate input is constrained by the technology adaptation capacity, which is dependent on aid as well as uniform skill level of the labourers. Thus South is capable of using only a

subset of the entire range of intermediates produced by the North.

3) The quantum of foreign aid is fully targeted for technology adaptation and is assumed to be a constant percentage of output in the North. This roughly corresponds to reality for the last three decades where aid as a fraction of GNP of Development Assistance Committee (DAC) members is constant (Svensson, 1995).

4) It also imports the Northern final good and exports its own final good to the North. However, it is assumed that the Southern people's share of expenditure on the Southern good (γ_S) is greater than that of the Northern people (γ_N), that is $\gamma_S > \gamma_N$.

The motivation behind assumption (2) above in respect of the South is the paper by Coe, Helpman and Hoffmaister (1995) and Easterly et al (1994) mentioned in the overview section. Thus, in our model, the range of intermediate good imported by the South is an indicator of aid effectiveness as well as the level of human capital in the South.

The equations of the model are described below.

II. SUPPLY SIDE

A. Final good sector

1) Production function (North):

$$Y_N = A_N L_{YN}^{1-\beta}\left[\int_0^n x_{N(\omega)}^{\rho}\, d\omega\right]^{\frac{\beta}{\rho}}$$

$$\text{where} \quad 0 < \beta, \rho < 1$$

2) Production function(South):

$$Y_S = A_S(hL_S q)^{1-\alpha}\left[\int_0^{n_1} x_{S(\omega)}^{\rho}\, d\omega\right]^{\alpha/\rho}, 0 < \alpha, \rho < 1$$

Here Yi denotes output in the ith country.

A_i denotes the productivity parameters in the ith country.

$x\,i(\omega)$ is amount of variety of intermediate input used in the ith country $i = N,S$

n is the total number of intermediate inputs used by the North.

n_1 is the total number of intermediate goods used by the South. By implication, $n > n_1$.

L_{YN} is the number of Northern labourers employed in the final good sector.

L_S is the number of labourers in the South who are fully employed in the final good sector.

h is the skill level of each labourer in the South.

q is the fraction of time devoted by each labourer in the production of the final good.

So hL_Sq is the total efficiency units of labour employed in the South.

$1/1-\rho = \varepsilon$ is the elasticity of substitution between any two inputs within the group and $\varepsilon > 1$ as $\rho < 1$.

β & α are the shares of the whole variety of intermediate inputs in the output produced by the North and the South respectively and we assume $\beta > \alpha$.

The production functions above show constant returns in labour and intermediate goods, but if the varieties are also increased at the same time, the production functions exhibit increasing returns. Thus varieties play the most important role in this type of production function known as Dixit-Stiglitz-Spence (Krugman, 1996) type of function.

3) Human capital Accumulation function for Human capital (in South):

$$\frac{\dot{h}}{h} = \delta\,(1 - q)$$

Here $\delta > 0$ is a productivity parameter and (1-q) represents the proportion of working hours devoted for acquiring skill or in schooling. We assume that the value of q is exogenously given. In other words human capital in our model grows at a fixed rate δ (1-q).

3a) Intermediate input use capacity (in South):

As explained in the assumptions, the capacity of the South to use intermediate goods is conditioned by its technology adaptation capacity , which on its part, depends on the constant proportion (to GDP) of foreign aid from the North, as well as the level of skill of the labourers in South. This, if n_1 is the number of intermediates used by the South, out of a maximum of n produced by the North, then by our construct: $n_1 = \kappa(A_1)h = \kappa(\theta_1 Y_N)h = \kappa\theta_1 Y_N h$ (a linear approximation), where:

$A_1 = \theta_1 Y_N$ is the quantum of targeted foreign aid from the North to the South.

By assumption (3), θ_1 = Percentage of GDP given as aid = constant, and $0 \leq \theta_1 < 1$.

It is further assumed that foreign aid is taken to be a kind of transfer from the pre-transfer expenditure of people in the North on Northern final good, as if north sends a consignment of northern final product purchased by the consumers of the North on behalf of the South.

Pricing of final good:

4) North:

$$P_N = \frac{\left(\frac{W_N}{A_N}\right)^{1-\beta}\left[\int_0^n P_{x(\omega)}^{1-\varepsilon}\,d\omega\right]^{\beta/1-\varepsilon}}{A_N \beta^{\beta}(1-\beta)^{1-\beta}}$$

5) South:

$$P_S = \frac{\left(\frac{W_S}{A_S}\right)^{1-\alpha}\left[\int_0^{n} P_{x(\omega)}^{1-\varepsilon} d\omega\right]^{\alpha/1-\varepsilon}}{A_S \alpha^{\alpha}(1-\alpha)^{1-\alpha}}$$

Expressions for prices have been derived through marginal cost pricing.

B. R & D Sector(existing in the North only):

6) Production Function :

$$\dot{n} = \frac{L_n n}{a_{Ln}}$$

L_n= number of labour units devoted to R&D Sector

a_{Ln}=productivity parameter in R&D Sector

7) Cost and price of design(free entry in this sector ensures equality between price and average cost):

$Cn=W_N a_{Ln}/n$

[we assume Cn=1, that is, the design performs the role of a numeraire good]

C. Intermediate good sector:

The intermediate good sector is oligopolistic in nature. Each producer produces a particular variety. The producer of an intermediate good purchases design from the R&D sector. His decision to invest in design is given by the following condition:

$$8) \qquad \int_t^{\infty} e^{-(R(\tau)-R(t))}\pi_{e(\omega)}(\tau)d\tau = Cn(t)$$

R(t)=cumulative interest factor from time 0 to time t; R(0)=1

$\pi e_{(\omega)}$= expected profit of a firm producing the variety
LHS of the above equation= stream of discounted profit

9) No arbitrage condition:

$$\dot{R} = \frac{\dot{C}_n + \pi_e}{C_n}$$

The above condition is derived by differentiating equation (8) with respect to t (applying Leibniz's rule). This condition determines relative returns of having ownership claims in R & D firms or buying riskless bonds. We will return to this condition shortly.

If Cn = 1, we have 8 ') $\dot{R} = \pi_e$

10) Demand for intermediate good of variety in the North:

$$x_{N(\omega)} = \frac{P^{-\varepsilon}_{\chi(\omega)}}{\int_0^n P^{1-\varepsilon}_{\chi(\omega)}\, d\omega} \beta P_N Y_N$$

11) Demand for intermediate good of variety in the South:

$$x_{S(\omega)} = \frac{P^{-\varepsilon}_{x(\omega)}}{\int_0^n P^{1-\varepsilon}_{x(\omega)}\, d\omega} \alpha P_s Y_s$$

12) Profit equation:

$\pi_{e(\omega)} = n_1/n(\pi_{1(\omega)}) + (1-n_1/n)(\pi_{2(\omega)})$
where, $\pi_{1(\omega)} = \{P_{x(\omega)} - W_N a_{Lx(\omega)}\}(x_{N(\omega)} + x_{S(\omega)})$

and $\pi 2_{(\omega)}) = \{P_{x(\omega)} - W_N a_{Lx(\omega)}\}(x_{N(\omega)})$

a_{Lx}= unit labour cost to produce a variety ω

13) Price of intermediate good:

$P_{x(\omega)} = W_N a_{Lx(\omega)} / \rho$

The above expression is derived from the first order condition of profit maximisation given by $\partial\pi_{e(\omega)} / \partial P_{x(\omega)} = 0$

As all inputs enter into the production symmetrically,

$a_{Lx(\omega)} = a_{Lx} \quad \forall\ \omega$

and $P_{x(\omega)} = Px \quad \forall\ \omega$

14) Total demand for intermediate goods:

$X = \alpha P_S Y_S / P_X + \beta P_N Y_N / P_X$

15) Profit per firm:

$\pi_{e(\omega)} = (1-\rho)\ P_X\ [n_1 \alpha P_S Y_S / (n\ n_1 P_X) + \beta P_N Y_N / (n P_X)]$

$= (1-\rho)\ [\ \alpha P_S Y_S / n + \beta P_N Y_N / n P_X\ ]$

The output decision of a typical firm is based on an assessment of demand for that particular variety. Not all firms can sell their products in the Southern market, where only $n_1 (< n)$ varieties are purchased. Varieties n_1 are chosen randomly. Since this is not a vintage model, varieties with higher number tags do not signify higher level of technology. Hence the probability of being chosen (for any particular firm) is n_1/n.

D. Labour market:

North:

Assuming full employment in the Northern labour market we have

$L_n + L_x + L_{YN} = L_N$

where $L_n = aL_n \frac{n}{n}$ (i.e, amount of labour demanded in the R&D sector)

$L_x = a_{Lx}(\alpha P_S Y_S/P_X + \beta\, P_N Y_N/P_X)$ (i.e, amount of labour demanded in the intermediate good sector)

and $L_{YN} = (1-\beta\,)P_N Y_N/W_N$ (i.e, amount of labour demanded in the final good sector)

Labour market equilibrium condition:

16) $aL_n \frac{n}{n} + aL_x\,(\alpha P_S Y_S/P_X + \beta P_N Y_N/P_X) + (1-\beta)P_N Y_N/W_N = L_N$

Or, $$\frac{\rho\alpha P_s Y_s + (1-\beta+\rho\beta)P_N Y_N}{W_N} = L_N - a_{LN}g$$

Where, $\frac{n}{n} = g$ = growth rate of number of varieties of intermediate goods

South:

All the labourers (each having h amount of human capital) are employed in the final good sector but devote q proportion of total labour hours in final good production.

Labour market equilibrium condition:

17) $hqL_S = (1-\alpha)P_S Y_S/W_S$

III. Demand side: The demand determined model here has the following macro-economic balance relations (Bhagwati, Panagariya and Srinivasan, 2000; Jones, 1979):

18) Macroeconomic income-expenditure identity (North):

$$\alpha\, P_S Y_S + P_N Y_N = E_N - \theta_1 P_N Y_N + X_N - M_N$$

19) Macroeconomic income-expenditure identity (South):

$(1-\alpha)\ P_S Y_S = E_s + \theta_1 P_N Y_N + X_S - M_S$

Ei (i=N,S) = the expenditure on final goods (produced either in the South or North) by the people of the ith region in the absence of any transfer from the North to the South.

$\theta_1 P_N Y_N$ = Amount of targeted transfer (aid) from North to the South.

θ (an exogenous parameter) $= E_N/E_S$

$X_S = \gamma_N E_N$ and $M_S = (1-\gamma_S)E_S + \alpha P_S Y_S$

$X_N = (1-\gamma_S)E_S + \alpha P_S Y_S$ and $M_N = \gamma_N E_N$

Here X and M refer to export and import, respectively. The parameters g_N and g_S refer to the propensities of Northern and Southern people to spend on the final good produced in the South respectively. It is natural to assume: $\gamma_S > \gamma_N$.

Hence, we can write

20) $P_S Y_S = \gamma_S E_S + \gamma_N E_N + \theta_1 P_N Y_N$ and

21) $P_N Y_N = (1-\gamma_S)E_S + (1-\gamma_N)E_N - \theta_1 P_N Y_N$

22) Inter-temporal utility function of the consumers in each country

$$U_{it} = \int_t^\infty e^{-r(\tau-t)} \log\left[\beta_i C_{S\tau}^{\gamma i} C_{N\tau}^{1-\gamma i}\right] d\tau$$

where r = the subjective discount rate.

$C_{S\tau}$ = consumption of Southern final goods

and $C_{N\tau}$ = consumption of Northern final goods

(23) Inter-temporal budget constraint for the ith country(i=N,S) :

$$\int_t^\infty e^{-[R(\tau)R(t)]} E_i(\tau)d\tau \leq \int_t^\infty e^{-[R(\tau)-R(t)]} W_i(\tau)L_i d\tau$$

where, W_{it} = consumer's (of ith country) wage rate at time

L_i = labour supply in the ith country

(Since, there is no physical capital or asset in the system, interest rate is determined by the no-arbitrage condition in the North, which includes sale of intermediates to the South. Thus the interest rate is common to all individuals in the North and the South).

Consumers in each country maximize the utility function (22) subject to the budget constraint (23). With Ui ($=\beta_i C_{S\tau}^{\gamma_i} C_{N\tau}^{1-\gamma_i}$) linearly homogenous, this optimisation problem can be solved in two stages. First, the consumers maximise static utility for a given level of expenditure at time t, Ei(t). The solution to this problem generates an indirect utility function given by the form:

$$v[P_S(\tau), P_N(\tau)]\ E_i(\tau)$$

In the second stage we would find out the time pattern of expenditure Ei

$$V_{it} = \int_t^{\infty} e^{-r(\tau-t)}\left[\log v_i\left\{P_S(\tau), P_N(\tau)\right\} + \log E_i(\tau)\right]$$

by maximising:

subject to the budget constraint (23).

From the first order condition to this problem we find that the optimal path for Ei is given by the following equation:

$$24) \qquad \frac{\dot{E}_i}{E_i} = \dot{R} - r$$

On this optimal path the consumer is indifferent between a unit of extra saving and a unit of extra expenditure. Equation (24) may be interpreted as follows. Spending must grow at a rate equal to the difference between the interest rate and the subjective discount rate on the consumer's optimal path.

In our model, savings are used to accumulate ownership claims of the input producing firms in the North or riskless bonds issued by them.

Arbitrage ensures that the rates of return on these two assets are equal and in equilibrium consumers are indifferent as to the composition of their portfolios.

Solution of the system

A: Static solution:

From the set of equation [(1) to (20)] we can solve for W_N, W_S, P_S, P_N, Y_S, Y_N, X and P_X for given values of g, h, q, E_S, θ , θ_1, γ_S and γ_N.

B: Dynamic solution:

Here we would characterise the steady state and determine the long run values of some crucial macroeconomic indicators like the growth rate, TOT etc. There are three primary variables (E_S, n and h) which are changing over time. The rates of growth of these variables ultimately decide the growth of other variables. Among these three variables, h grows at a constant rate given by δ (1-q). We have defined the steady state as

$$\frac{\dot{E}_t}{E_t}=\dot{R}-r$$

Where, $\dot{R}-\mathrm{r}=\mathrm{g}$ or $\dot{R}-\mathrm{r}+\mathrm{g}$. From equation (8'), then, we have, $\dot{R}=\pi_e$, where the other two variables grow at the same rate. In other words, the steady state is defined by the condition

$$25)\quad \frac{\dot{Es}}{Es}=\frac{\dot{n}}{n}=g$$

Using the equation for profit

$\pi_e = (1\text{-}\rho)\ \beta\ E_S\ [\alpha(\gamma_S+ \theta\ \gamma_N)+ \beta\{1\text{-}\gamma_S +\theta(1\text{-}\gamma_N)\}]/n$

So, we get the following equation (26)

$(1\text{-}\rho)\ E_S\ [\alpha(\gamma_S + \delta\gamma_N)+ \beta\{1\text{-}\gamma_S + \theta(1\text{-}\gamma_N)\}]/n = r\text{+}g$, Or

(26) $(1-\rho)e_S[\alpha(\gamma_S+\theta\gamma_N)+\beta\{1-\gamma_S+\theta(1-\gamma_N)\}]= r+g$

Now from Northern labour market equilibrium condition we have

$W_N L_N = W_N\, a_{Ln}\, g + \rho\alpha\, P_S Y_S + (1-\beta+\rho\beta)\, P_N Y_N$

But, $W_N\, a_{Ln/n} = 1$

So, $L_N/\, a_{Ln} = n\, g + \rho\alpha\, P_S Y_S + (1-\beta+\rho\beta)\, P_N Y_N$

Using equation (17) &(18) we have

27) $e_S[\rho\alpha(\gamma_S+\theta\gamma_N) + (1-\beta+\rho\beta)\{1-\gamma_S+\theta(1-\gamma_N)\}] = L_N/\, a_{Ln} - g$

Solving equations (24)&(25)we can find

28) Long run solution for e_S ($=e_S{}^*$):

$$e^*_S = \frac{\dfrac{L_N}{a_{LN}} + r}{\alpha(\gamma_s+\theta\gamma_N)+1-\gamma_s+\theta(1-\gamma_N)}$$

29) ***Long run solution for g (=g*):***

$$g^* = (1-\rho)[\alpha(\gamma_S+\theta\gamma_N)+\beta\{1-\gamma_S+\theta(1-\gamma_N)\}]\frac{\dfrac{L_N}{a_{Ln}}+r}{\alpha(\gamma_S+\theta\gamma_N)+1-\gamma_S+\theta(1-\gamma_N)} - r$$

$$= \frac{\dfrac{L_N}{a_{LN}\varepsilon}}{\alpha(\gamma_s+\theta\gamma_N)+\{1-\gamma_s+\theta(1-\gamma_N)}[\alpha(\gamma_s+\theta\gamma_N)+\beta\{1-\gamma_s+\theta(1-\gamma_N)\}]-$$

$$r[\frac{\rho\alpha(\gamma_s+\theta\gamma_N)+(1-\beta+\rho\beta)(1-\gamma_s+\theta(1-\gamma_N))}{\alpha(\gamma_s+\theta\gamma_N)+1-\gamma_s+\theta(1-\gamma_N)}]$$

So, the sufficient condition for a positive g^* is

$$\frac{L_N}{\varepsilon a_{LN}}[\alpha(\gamma_S+\theta\gamma_N)+\beta\{1-\gamma_S+\theta(1-\gamma_N)\}]>$$
$$r[(1-1/\varepsilon)\alpha(\gamma_S+\theta\gamma_N)+(1-\beta+\rho\beta)\{1-\gamma_S+\theta(1-\gamma_N)\}]$$

From the above expression we can arrive at following two sufficient conditions

i) $L_N / \varepsilon a_{Ln} > r(1-1/\varepsilon)$

or, $L_N / a_{Ln} > r(1-1/\varepsilon)\varepsilon$

or, $1+L_N / ra_{Ln} > \varepsilon$

ii) $\beta - r(1-\beta+\rho\beta)>0$

or, $\beta/(1-\beta+\rho\beta)>r$

In the above exercise we have arrived at a 'jump equilibrium'. Such equilibrium is characterised by the fact that the system must necessarily have a consistent solution for any set of values of the parameters. There cannot be any out of equilibrium solution- for each set of parameters, we have an equilibrium g and corresponding e_S Thus we do not have any transitional dynamics. The variable g is a jump variable and the system instantaneously jumps to equilibrium, as in Helpman (1992).

Before going into the derivation of steady state growth rates of North and South, we need to know the expressions for the prices of Northern and Southern final goods, namely, P_N and P_S respectively. From the labour markets of North and South, one gets the expressions for wages in the North and the South. Using these expressions and the pricing equations in equations (4) and (5), as well as the equation (13) for the intermediate goods pricing, we get the following equilibrium values for the prices as follows (proofs are available from the authors on request):

30) $P_N = E_N B n^{\beta(1-\varepsilon)}$, where B = a constant composed of production function parameters of final good and intermediate goods in the North.

31) $P_S = (E_S A) / Y_N^{\alpha(\varepsilon-1)} h^{(1-\alpha-\alpha(\varepsilon-1))} q^{1-\alpha}$, where A = a constant composed of production function parameters of final good in the South and Intermediate goods in the North.

Again, using equations (20), (21), (30) and (31) above we derive the Northern and Southern growth rates as follows:

The growth rate of Northern output (g_N):

$$g_N = \frac{\dot{Y}_N}{Y_N} = \frac{\dot{E}_N}{E_N} = \frac{\dot{P}_N}{P_N} \quad \text{(since } \theta = \text{constant by assumption)}$$

$$= \frac{\dot{E}_S}{E_S} - [(1-\beta)\frac{\dot{W}_N}{W_N} + \frac{\beta\frac{\dot{n}}{n}}{1-\varepsilon} + \beta\frac{\dot{P}_x}{P_x}]$$

But at the steady state $\frac{\dot{E}_S}{E_S} = g*$, so the steady state value of g_N (g_N^*) is given by

32) $g_N^* = \beta g^* / (\varepsilon - 1)$

Hence g^* determines the long run value of g_N

Similarly the ***steady state growth rate of the Southern output (g_S*)*** is given by .

$$33)\ g_S{}^* = \{\frac{\dot{Y}_S}{Y_S} = \frac{\dot{E}_S}{E_S} = \frac{\dot{P}_S}{P_S} = \frac{\alpha}{\varepsilon-1}(\frac{\beta}{\varepsilon-1}g^*) + \delta(1-q)[1-\alpha+\alpha/(\varepsilon-1)]\}$$

From the above equations it is easy to check that the terms of trade P_S/P_N (TOT) depends on the difference of growth rates between the North and the South as follows:

34) $g_{TOT}^* = g_N^* - g_S^*$. This result follows from the fact that E_N and E_S have a fixed proportionate relation. TOT growth rate is negative if $\varepsilon < 1+\alpha$. So under this value of the elasticity of substitution, terms of trade will move

against the south continuously over time. But as shown below, this does not mean the South is worse off as a result of this adverse movement. Before that we define another growth variable involving ratio of n_l to n. This determines whether n_l grows faster than n or vice-versa.

35) $\dot{g}_{nl} = \frac{\dot{n}_l}{n_l} - \frac{\dot{n}}{n} = \delta(1-q) + (\beta/(\varepsilon-1))g^* - g^*$. It is clear that g_{nl} is positive if $\varepsilon < 1 + \alpha$ since $\alpha < \beta < 1$.

Importance of Aid and its Type:

Herein comes one of the most important implications of the model. The Northern growth rate affects the Southern growth rate because of the aid term. In case there is no aid for technology adaptation from the North, the southern growth rate would have been completely independent of the Northern growth. It would depend on the growth of human capital only. There is a definite positive impact of aid on southern growth.

The importance of the type of aid is crucial here. In case, the aid is given just for additional consumption, it is clear from equations (20) and (21), growth rates would have been the same. The reason is simple. The aid parameters do not enter the production function, hence do not affect the pricing equations. In fact, the first kind of aid for technology adaptation, by increasing the variety of intermediate inputs in the south, plays the role of increasing returns to scale. This increases the growth rate of southern output than otherwise. Simple aid acts as a transfer to raise consumption and does not raise growth rate of the South. This is similar to what has been obtained by others also (Boone, 1996)

We would now study the relative welfare positions of the two regions. At any point of time the relative welfare position of the South with respect to that of the North can be measured using the indirect utility function. The relative indirect utility of the South is given by:

$$36)\quad \frac{I_S}{I_N} = \frac{\phi}{\theta\left(\frac{P_S}{P_N}\right)^{\gamma_S-\gamma_N}}$$

Where, $\phi = \left(\frac{\beta_s}{\beta_N}\right)\left[\frac{\gamma_S^{\gamma_S}(1-\gamma_S)^{1-\gamma_S}}{\gamma_N^{\gamma_N}(1-\gamma_N)^{1-\gamma_N}}\right]$

As $\gamma_S > \gamma_N$, Southern relative indirect utility is inversely related to the TOT. So in the steady state, relative welfare and relative output of the South move in the same direction provided that the Southern people's propensity to spend on the Southern good is higher than that of the Northern people.

Effect of parametric change on the steady state values:

We represent the results in the following tabular form. The parameters considered by us are L_N, L_S , r , q , ε , θ , β , α, γ_S, and γ_N

Table 3: Effects of Parametic Changes on the Steady State Values of Different Variables

Variables	L_N	L_S	θ	q	ε	r	α	β	γ_S	γ_N
g^*	+	0	-	0	-	-	+	+	+	+
e_S^*	+	0	-	0	0	+	-	0	+	+
g_N^*	+	0	-	0	-	-	+	+	+	+
g_S^*	+	0	-	-	-	-	+***	+	+	+
$g_{TOT}^* = g_N^* - g_S^*$	+	0	+*	+	+*	+*	-*	+*	+	+
g_{nl}^*	+	0	-	-	-**	-**	+**	+**	+**	+**

NOTE: * implies the sufficient condition ε < 1+α

** implies the sufficient condition ε < 1+β

*** implies the sufficient condition ε < 2

From Table 3 we can make following observations:

i) The volume of the Northern labour force affects all the variables positively.

ii) The Southern labour force has no effect on any of the variables;

iii) The time allocation parameter *q* can only affect g_S^*, g_{nl}^* and TOT growth g_{TOT}^*. For the first two growth rates, the effect is negative whereas for the TOT it is positive;

iv) The effect of ε on g^*, g_N^* and g_S^* is negative. But its exact effect on g_{TOT}^* is positive. However ε has no effect on e_S^*;

v) The asymmetry parameter θ has a positive effect only on g_{TOT}^*.

vi) Subjective discount rate r affects all the variables (except e_S^* & g_{TOT}^*) negatively. The effect of r on e_S^*& g_{TOT}^* is positive.

vii) The production parameters β and α have positive effects on g^*, g_N^*, g_{nl}^* and g_S^*. e_S^* is negatively affected by α but not affected by β. β affects the Terms of Trade growth rate positively, but α affects it negatively.

vii) The demand parameters γ_S and γ_N affect all the variables positively.

Major findings of the Model:

The most striking implication of the model above is the vital role which the foreign aid variable plays in this model. In case there is no aid, the Southern growth rate would have been independent of the northern variables like northern output, labour force and demand parameters like γ_N and α. Aid performs here the role of technology adapter. It allows the southern economies to enjoy a faster growth in the number of intermediate goods used as compared to that of northern economies. The result is quite intuitive- the south enjoys more economies of scale relative to the north. As a consequence, the south enjoys a faster growth than the north (interestingly, propelled by north's growth itself due to the type of aid envisaged) and at the same time experiences a falling terms of trade, which might accelerate over time as well! But does it mean south faces impoverishment and immiserisation? The answer is unambiguous no. South improves its welfare vis-à-vis the north. And what is the catalyst here? This is the variable, which we labeled the targeted aid.

Finally we should highlight some features of the southern TOT in this model. The TOT

(P_S/P_N), and not its growth, is given by:

$$\frac{P_S}{P_N} = C\frac{{Y_N}^{\frac{\alpha}{1-\epsilon}}}{h^{1-\alpha+\frac{\alpha}{1-\varepsilon}}}\frac{1}{q^{1-\alpha}}\frac{1}{n^{\frac{\beta}{1-\epsilon}}}\frac{1}{{L_S}^{1-\alpha}}, \tag{37}$$

Where C =a constant having production function and demand function parameters of both the South and the North.

We can see that the rise in effective labour force of the south leads to fall in TOT.

Now, effective labour force in South may rise due to rise in L_S, h or q, individually or simultaneously. A rise in L_S alone reduces TOT, but does not affect the growth rate of South although it raises the static welfare level. The movements in q and h are opposite to each other. With development, it is expected that q will fall and a fall in q raises the TOT for immediate future, although causing it to fall after time assumes large values (time exceeding the value of $1/\delta q$). In case of small values of δ and high values of q, the time needed to bring a fall in TOT may be abnormally high. The southern growth rate however, rises unambiguously. However, the aid factor, driven by the growth rate of northern output Y_N, clearly reduces the TOT while raising the southern growth rate g_S, thereby fitting the data in Table 2 above most suitably. So, in this model the importance of skill upgradation and technology adaptation is clearly discernible. While skill upgradation's impact is time-dependent, the aid component has a time-invariant impact. One should note that the deterioration in Southern TOT is not detrimental to the static Southern welfare in our model. Increased variety of intermediate goods in Southern production generates economies of scale and reduces the cost of production. As a result the demand for Southern product rises and the economy grows accordingly.

Concluding remarks- Implications for future policies:

The analytical model discussed above leads to some conclusions, which are different from the traditionally received ideas. Though the South has to depend on the North for the essential intermediate inputs for final good production, it grows faster than the North because of the targeted aid which the North provides to the South for technology adaptation. Also, South could accelerate growth through skill upgradation, although this is rather time-consuming. In other words we have deviated from the typical Findlay (1980,1981) type results, which tell us that the long run growth rate in the global economy is solely determined by the exogenous growth rate of the North and the South keeps parity with that rate via the adjustment of its TOT.

However, the higher growth rate in the South relative to that of the North is associated with the deterioration of the Southern TOT. But this fall in TOT raises the relative welfare of the Southern people under a realistic assumption ($\gamma_S > \gamma_N$). Again there is a contradiction with the opinion of the dependency school. TOT deterioration, according to that school, cannot be beneficial for a Southern country. Because of low elasticities of demand (both with respect to price and income) of its exportables (which are in most of the cases primary goods), the South suffers from balance of payment crisis. Also, the South becomes a net loser in international trading activities on account of unequal exchange. But in our model, deterioration of the Southern TOT implies cost efficiency on the part of South. By considering technology adaptation and human capital accumulation in the South along with Romer-type production function we have been able to show how the rise in the technology adaptation and skill level can cause economies of scale and raise relative static welfare of the Southern people via the deterioration of the TOT (by reducing the average cost and the price of the Southern good). In our demand-determined model, relative fall in the Southern price leads to a rise in the Southern output and welfare relative to that of the North. In other words, there is no reason for the South to suffer from its TOT deterioration.

As a whole our model suggests that one need not be too pessimistic regarding the North-South global economic relations. Even being technologically dependent on the North, the South can improve its own position with its own policy decisions as well as through the right kind of foreign aid from the North. As discussed earlier, the role of foreign aid largely determines the role of Developed nations in enhancing the growth and welfare of the developing countries. The policy implication must be elaborated more clearly as follows:

a) The developing countries, many of which have moved out of the primary goods production syndrome, are dominated by small and medium industries. The major problem faced by these industries is their limitations to import varieties of intermediate inputs from the developed countries since these industries simply lack the capability and knowledge of adapting the associated technologies (Chatterjee and Raychaudhuri, 1996; Marjit and Raychaudhuri, 1997).

b) It has been proved beyond doubt (as elaborated in the overview section earlier) that the trade in intermediate inputs transfer the fruits of modern R & D from the research laboratories of the developed economies to developing countries- it may vary from information technology and engineering products to garments and leather manufacturing. This becomes crucial in the current phase of tariff reduction and economic liberalization throughout the developing world, leading to the overall emergence of non-price competition as the most important factor in international trade. One of the most important non-price factors is quality and technology (Marjit and Raychaudhuri, 1997). Whatever the developing world lacks in this area can be more than compensated by the intermediate inputs trade.

c) The major impediment to increase the range of intermediates in the production sector of the developing countries is its low capacity of technology adaptation and low level of human skill. However, it is widely believed, too much efforts have gone into raising human skill and results thereof does not measure up to the expectation (World Development Report, 1995).

Technology adaptation is mentioned time and again, but an integrated strategy to implement this has not been discussed in the global policy framework (Watson, Crawford and Farley, 2003). It has been found in latest research that product innovations in SMEs are driven by initial skill endowment as well as self-motivation. Incremental innovations depend on customer pressure as well as competition (Bala Subrahmanya, 2003). In both cases, aid for technology adaptation could be a big boost.

d) The donor countries and aid agencies, who have experimented with a variety of forms and types of foreign aid, have to repose new faith on targeted foreign aid towards technology adaptation, especially by Small and Medium industries in developing countries. This needs to be done through close cooperation with national governments, private industrial associations and research institutions (ESCAP, 2002)

The present paper establishes the clear superiority of targeted foreign aid to adapt technology, in order to import more varieties of intermediate goods by the developing world, over other forms of foreign aid in this integrated model. This gives an analytical framework to define the role of developed countries and donor agencies in shaping the future of developing countries in a significant manner. The major research, which need be undertaken to supplement the findings here, can be summarised as follows:

a) To search for the optimal incentive structures on the part of Small and Medium producers to accept such strategies. This requires identification of the most promising industries who are likely to benefit the most over time.

b) To explore ways of sustainable cooperation among governments of donor and recipient countries, research institutes in developing countries and entrepreneurs to spread the adaptation among industries in the South.

c) To monitor the effectiveness of such strategies in order to understand whether these are the so-called win-win situation for the donor and recipient country citizens.

REFERENCES

Banerjee, A. and R. He (2003) 'The World Bank of the Future'. Cambridge: MIT, Mimeo.

Bala Subrahmanya, M.H. (2003) ' Technological Innovations in Small Enterprises'. Economic and Political Weekly, May 24.

Barro, R.J. and X. Sala-i-Martin (1995) Economic Growth. McGraw-Hill, International edition.

Benarroch, M. and J. Gaisford (2001) 'Foreign Aid, Innovation and Technology Transfer in a North-South Model with Learning By Doing'. Discussion Paper No. 1999-09, University of Calgary, Department of Economics.

Bhagwati, J.N., A. Panagariya, and T.N. Srinivasan (1998) Lectures on International Trade. Cambridge: The MIT Press, Chapter 16.

Bhattacharya, J and A. Raychaudhuri (2004) "Endogenous growth in a North?-?South framework with human capital accumulation and technology transfer," Journal of International Trade & Economic Development, 13(1), 23-56.

Boone, P (1995) 'Politics and Effectiveness of Foreign Aid'. CEP Discussion Paper No. 272. London: London School of Economics.

Burnside, C. and D. Dollar (1997) 'Aid, Policies and Growth'. World Bank Policy Research Working Paper No. 1777.

Caselli, F. and Coleman II, W. J. (2001) 'Cross-Country Technology Diffusion: The Case of Computers'. Harvard University, Mimeo.

Caselli, F. and Wilson, D. (2003) 'Importing Technology'. Paper prepared for the *Carnegie-Rochester Conference on Public Policy,* Harvard University, Mimeo.

Chatterjee, B. and A. Raychaudhuri (1996) 'Some Aspects of Production Organization and Cost Behaviors of Garments Industry in West Bengal' in A.Raychaudhuri and D.Sarkar (eds.) Economy of West Bengal: Problems and Prospects. New Delhi: Allied Publishers and DSA Centre for Regional Economic Studies, Jadavpur University.

Coe, D.T. and E.Helpman (1995) 'International R & D Spillovers', European Economic Review, 39,859-887.

Coe, D.T., E. Helpman, and A.W. Hoffmaister (1995) 'North-South R&D Spillovers'. NBER Working Paper No. 5048.

Dalgaard, C-J and H. Hansen (2001) 'On Aid, Growth and Good Policies', Journal of Development Studies, 37(6), 17-41.

Dalgaard, C-J, H. Hansen and F.Tarp (2002) 'On the Empirics of Foreign Aid and Growth'. CREDIT working paper, University of Nottingham.

Devarajan, S., A. S. Rajkumar, and V. Swaroop (1999) 'What does Aid to Africa Finance?' World Bank Development Research Group Working Paper.

Drazen, A. (1999) 'What is Gained By Selectively Withholding Foreign Aid?'. University of Maryland, Mimeo.

Easterly, W. (1998) 'Quest for Growth'. World Bank, summary.

Easterly, W. R. King, R, Levine, and S. Rebelo (1994) 'Policy, Technology Adoption and Growth'. NBER Working Paper No. 4681.

Easterly, W., R. Levine and D. Roodman (2003) 'New Data, New Doubts: A Comment on Burnside and Dollars "Aid Policies and Growth"(2000)'. Centre for Global Development Working Paper No. 26.

Eaton, J. and S. Kortum (2000) 'Trade in Capital Goods'. NBER Working Paper No. 8070.

ESCAP (2000) Report of the Regional Consultative Meeting on Strengthening Technology Incubation System for Creating High-technology based Enterprises, Seoul, 2000.

Findlay, R (1980) 'Terms of Trade and Equilibrium Growth in the World Economy'. The American Economic Review 70, 291-99.

————————(1981) 'Fundamental Determinants of the Terms of Trade'. In Grossman S. and E. Lundberg, (eds) The World Economic Order: Past and Prospects. London: Macmillan, 425-57.

Grossman, G. and E. Helpman (1990) 'Comparative Advantage and Long-run Growth'. The American Economic Review 80, 796-815.

Helpman, E. (1992) 'Innovation, Imitation and Intellectual Property Rights' Discussion Paper No. 1597, Harvard Institute of Economic Research, Harvard University.

Heyneman, S. (2003) 'The Social Aspects of the Millennium Challenge Account: Risks and Prospects' in Economic Perspective, March, 2003. Washington, D.C.: U.S. Department of State.

Jones, R. (1979) International Trade: Essays in Theory. Amsterdam: North-Holland Publishing Company, Chapter 10 and 11.

Keller, W. (1996) 'Absorptive Capacity: on the Creation and Acquisition of Technology in Development'. Journal of Development Economics 49, 199-227.

Keller, W. (1997) 'Trade and The Transmission of Technology'. NBER Working Paper No. 6113.

Krugman, P.R. and M. Obstfeld (2000) International Economics. Massachusetts: Addison-Wesley.

Krugman, P.R. (1996) Rethinking International Trade. Cambridge, MA: The MIT Press.

Lewis, A. (1954) 'Economic Development with Unlimited Supply of Labour'. Manchester School of Economic and Social Studies 21, 139-91.

————(1969). Aspects of Tropical Trade, 1883-1965. Stockholm: Almqvist and Wicksell.

Lucas, R. (1988) 'On the Mechanics of Economic Development'. Journal of Monetary Economics 32, 3-42.

Maizels, A., T.B. Palaskas and T. Crowe (1998) 'The Prebisch-Singer Hypothesis Revisited' in D. Sapsford and J-r. Chen (eds) Development Economics and Policy: The Conference Volume to celebrate the 85th Birthday of Professor Sir Hans Singer. Basingstoke and London: Macmillan, 63-85.

Marjit, S. and A. Raychaudhuri (1997) India's Exports: An Analytical Study. Delhi: Oxford University Press.

Mayer, J. (2003) 'The Fallacy of Composition: A Review of the Literature'. Discussion Paper No. 166. Geneva: UNCTAD.

Prebisch, R. (1950) The Economic Development of Latin America and its Principal Problems. New York, United Nations.

Rogoff, K. (2003) 'The IMF Strikes Back'. Foreign Policy, January/February, 39-46.

Romer, P. (1986) 'Increasing Returns and Long-run Growth'. Journal of Political Economy 94, 1002-37.

Romer, P. (1990) 'Endogenous Technological Change'. Journal of Political Economy, 98 (5, Part 2), S 71- S 102.

Sarkar, P. (1999)'Export Diversification, Market Shares and Issues of North-South Terms of Trade'. Mimeo, Centre for Studies in Social Sciences Calcutta.

Schaefer, B.D. (2003) 'Promoting Growth and Prosperity in the Developing World Through Economic Freedom' in Economic Perspective, March, 2003. Washington D.C.: U.S. Department of State.

Schiff, M., Y. Wang and M. Olarreaga (2002) 'Trade-Related Technology Diffusion and The Dynamics of North-South and South-South Integration'. World Bank Policy Research Working Paper 2861.

Singer, H. (1950) 'The Distribution of Gains between Investing and Borrowing Countries'. The American Economic Review 40, 473-85.

Stiglitz, J.S. (2002) Globalization and Its Discontents. N.Y.: W.W.Norton & Company.

Svensson, J. (2003) 'Why Conditional Aid Does Not Work and What Can Be Done About It?'. Journal of Development Economics, 70, 381-402.

Svensson, J. (1995) 'When Is Foreign Aid Policy Credible? Aid Dependence and Conditionality'. Mimeo. Stockholm: Institute of International Economic Studies.

UNCTAD (1996) Trade and Development Report, 1996.

U.S. Department of State (2003) Economic Perspective (An Electronic Journal), March, 2003

Vasquez, I. (2002) 'Foreign Aid and Economic Development' in Cato Handbook for Congress. Washington, D.C.: Cato Institute.

Watson, R., M. Crawford and S. Farley (2003) 'Strategic Approaches to Science and Technology in Development'. World Bank Policy Research Working Paper No. 3026.

World Development Report, Various Years. Washington, D.C.: World Bank and N.Y.: Oxford University Press.

Young, A (1991) 'Learning by Doing and Dynamic Effects of International Trade'. Quarterly Journal of Economics106, 369-405.

Empirics of Child Labour and the inverted U: A Pluralistic approach

Atanu Sengupta

Reader, Burdwan University, Burdwan, India

E-mail: sengupta_atanu@yahoo.com

Manas Ghose

Guest Lecturer, Raja N.L. Khan Women's College,
Vidyasagar University, Midnapore (West), India

E-mail: manasghose@yahoo.co.in

ABSTRACT

The problem of child labour is a multifaceted hydra. It is simply not possible to comprehend the problem using some simple theoretical constructs or causal empirics. Various aspects of this phenomenon are considered here. Specifically we concentrated on the so-called inverted U-hypothesis that posits a rise in child labour as family asset rises while falling eventually. For this, we have considered different types of regressions. Our study reveals the inverted U hypothesis to be valid in those cases where the probability of a child being send to labour market (given the other conditions) is very low. In such cases a rise in family assets, enhance the utilization of child labour.

Keywords: child labour, abusive labour, fragmented labour market, social issues, poverty.

JEL Classification Numbers: J7, J42, I3, D11, D12

The authors are thankful to an anonymous referee of this journal for his/her valuable comments on an earlier version of the paper. They are solely responsible for remaining errors, if any.

1. Introduction:

Economists are concerned about child labour mostly because of its abusive nature and its negative infringement on the process of human capital formation. The child labour model is peculiar in that the labouring child does not decide her fate-this is determined by her parents (Basu and Van 1998). However if child leisure is a "luxury" to the parents, not all children will be employed. A bad equilibrium where children work coexists with one where they do not work.

However the empirical literature on child labour seemed to have questioned the luxury axiom. Instead, an "inverted U" relationship was found between the child labour use and the family assets. At a very low level, a rise in family asset may increase the use of child labour (Basu, Das and Dutta 2007, Bhalotra and Heady 2003). However when family assets rise substantially, it may fall. The argument simply flows from the fact that with poor asset base, a family finds it difficult to employ child labour. However, as the family asset level rises, such impediments towards utilizing child labour may be removed thereby enhancing the use of child labour. At a still higher asset level, the family may opt for a gainful use of child through human capital formation. The relationship between child labour use and family asset is thus inverted-U shape.

However, the problem of child labour is a multifaceted hydra. It is simply not possible to comprehend the problem using some simple theoretical constructs or a single set of equations. Multiplicity and plurality is the norm here. In fact, the problem transcends well beyond the narrow boundary of a single discipline.

This paper is however empirical. Here we are concerned with the alternative models of child labour whereby several factors are important in each of these alternative specifications. Without declaring any one of these models as "best fit", what we try here is to chalk out the phenomenon that may transcended the differences in model specifications. The pluralistic flavour in our analysis may have some justification in the statement by Basu and Van (1998) "Finally, it is important to emphasize that the phenomenon of child labor has important sociological and psychological issues at stake. .... *There is no choice but to dissect such a large phenomenon into several parts and to analyze these one at a time.*" (italics ours).

In order to comprehend the problem it is first necessary to distinguish between **child labour** and **exploitation of child labour**. It has been accepted that a certain amount of child labour will persist under the family environment, which is non-exploitative. This is not only inevitable but also desirable[1]. At the same time, there are other forms of child work such as in hazardous occupations, factories and other organized establishments, begging and prostitution, which are repressive and should not be allowed to continue. The Indian Government has taken some steps to alleviate this monumental problem. In 1989, India invoked a law that made the employment of children under age 14 illegal, except in family-owned factories. However, this law is rarely followed, and does not apply to the employment of family members. Thus, factories often circumvent the law through claims of hiring distant family. In addition, in rural areas, there are few enforcement mechanisms, and punishment for factories violating the mandate is minimal, if not nonexistent.

Again, there is a definitional problem involving child labour (Mondal 2009). NSSO identified a set of activities as 'economic activity' that includes all productive activities, household or market-oriented, undertaken by a child (6-14 years of age) in a paid or unpaid capacity. However, in this paper we have also included some *uneconomic activities* such as begging, prostitution etc. and the children who are engaged with such activity within the purview of child labour[2]. Further NSSO introduce a new concept-**potential child labour** defined as the children worked as a paid or unpaid labour within or outside the family in the childhood age but did not work due to sickness or other reasons or the children who sought or seeking/available for work (Unemployed). This definition is very important. It identifies those fringe areas where the possibility to enter the labour market remains exceptionally high. Inclusion of such concepts within the purview of child labour helps us to broaden the concept of child labour in a meaningful way.

---

[1] Sociologists argue that such minimal sharing of family chores is a joyful activity and an essential part of the socialization process of the child. However when such jobs hinder the basic development of child and her rights, they turn out to be exploitative. In the standard literature (Basu and Van 1998: Basu, Das and Dutta 2007, Bhalotra and Heady 2003 Carpio 2007). we deal with this second type of child labour.

[2] In fact, they may be referred to as "**distress child labour**". **Obviously, they are the worst form of child labour.**

In this paper, we want to give a pluralistic view about pattern and causes of child labour in an Indian state with the emphasis on verifying the inverted U hypothesis. Our paper is divided as follows. In the next section, we give a brief description of our data and methodology. Section 3 gives a brief data description, in section 4 we describe the results of basic econometric analysis. We conclude the paper in section 5.

2. Data and Methodology

For empirical analysis, we have used the National Sample Survey Organization (NSSO) 62nd (2005-2006) round Unit Level data on Employment and Unemployment Situation in India. It is a detailed all India data covering all the major states and union territories of India. However, for this paper, we have selected only one state, West Bengal for our study. The choice of the state is purposive. There are several reasons for selecting the state. This state shows wide socio-economic, cultural and religious variations. However, in the recent decades, West Bengal has made some progress in agrarian growth and rural development. It is to be seen how far such changes are reflected in the use and allocation of child labour.

Most of the research on this topic (Goldin, 1979; Horan and Hargis, 1991; Bonnet, 1993; Basu, 1999a; Ray, 1999, Basu, Das, Dutta, 2007, Bhalotra and Heady 2003,.Carpio 2007) observed that child labour is mainly caused by economic factors such as income, assets (land, livestock etc.). But in this paper we want to incorporate the influence of family education level and number of children in the family, ratio of consumer to adult worker. Again our data enables us to compare the situations in the rural areas with the urban areas, male headed families with the female headed families etc. Since not all the sample families use child labour, the dependent variable is truncated at zero. Hence, the use of Ordinary Least Squares (OLS) technique is inappropriate for this analysis. Instead, we propose to use the Tobit regression technique that is suitable for such analysis.

3. Data Descriptions

3.1. Basic information

We now consider some basic socio-economic features of the sample state; they are given in Tables 1, 2 and 3. We have found the data on 5479 families, out of these 47.65% are rural families and 52.35% are urban families. Classifying another way we have found that 89.72% families are headed by a male member and 10.28% families are headed by a female member.

Table 1: Demographic profile of the sampled population

Child sex ratio (0-14) years	942
Child sex ratio, below 6 years	980
Child sex ratio (6-14) years	922
Sex ratio of child labour (6-14 years)	905
Sex ratio of child labour (10-14 years)	890
Sex ratio of potential child labour (6-14 years)	898
Sex ratio of potential child labour (10-14 years)	554
Adult sex ratio	911

# Source: Authors' estimate from NSSO 62nd (2005-2006) round Unit Level data on Employment and Unemployment Situation in India.

From Table 1 we have seen that adult sex ratio (911) is very bad but child sex ratios are 942 (0-14 years) and 980 (below 6 years) are relatively larger. This is due to continuous neglect of girl child and the difficulties that she has to withstand vis-à-vis her male counterpart unraveling a sad story of *withering* away of girls as their age increases. The same fact is also reflected by sex ratios of child labour as well as potential child labour where it is 905 for 6-14 years and 890 for 10-14 years child labour and 898 for 6-14 years and 554 for 10-14 years potential child labour.

Table 2: Educational attainment by the adults	
Average years of schooling by adult male	7.35
Average years of schooling by adult female	5.38
Average years of schooling by the family head	6.09
Literacy rate	81.29

# Source: Authors' estimate from NSSO 62nd (2005-2006) round Unit Level data on Employment and Unemployment Situation in India.

Next we consider the educational attainment of the sample families. Literacy rate of the sampled families is (81.29%) not bad but average years of schooling by adult male (7.35) as well as adult female (5.38) both are low. Average years of schooling by adult female is much lower than average years of schooling by adult male that imply prevalence of high gender deprivation.

Table 3: Poverty and access to public distribution of the sample	
Percentage of APL families	63.7
Percentage of BPL families	18.89
Percentage of Antyodaya families	1.79
Percentage of families which have others type ration card	4.5
Percentage of families which have no ration card	11.12
Total	100

# Source: Authors' estimate from NSSO 62nd (2005-2006) round Unit Level data on Employment and Unemployment Situation in India.

Our next important issue is the incidence of poverty. Basu and Van (1998) epitomized the issue in their famous luxury axiom. It is argued that families that can barely sustain their subsistence needs opt for child labour. The official estimate of poverty -percentage of Below Poverty Line (BPL) families is low (about 19%) while that of the very poor (Antyodaya families) is insignificant (about 2%). However, sizeable portions of the families (11.12%) have no ration card. It might be a reflection of illegal transnational migration (possibly from the neighboring countries) and poor administration. In that case, the conditions of these families are very precarious.

3.2. Incidence of child labour

Incidence of child labour for different category is shown in table 4, 5 and 6. By incidence we mean the percentage of children, (6-14) years, working as child labour.

Table 4: Sex wise incidence of child labour (% of total child)

Name of the variables	Male	Female
Incidence of child labour, (6-14) years	31.18	30.61
Incidence of child labour, (10-14) years	19.20	18.54
Incidence of potential child labour, (6-14) years	7.37	7.18
Incidence of potential child labour, (10-14) years	4.66	4.08

# Source: Authors' estimate from NSSO 62nd (2005-2006) round Unit Level data on Employment and Unemployment Situation in India.

Table 4 shows the sex wise incidence of child labour. From this table we have seen that incidence of child labour for both the types and both the age groups is higher for male than female.

Table 5: Region wise incidence of child labour (% of total child)

Name of the variables	Rural	Urban
Incidence of child labour (6-14) years	30.60	31.35
Incidence of child labour (10-14) years	18.18	19.89
Incidence of potential child labour (6-14) years	6.96	7.73
Incidence of potential child labour (10-14) years	4.17	4.69

# Source: Authors' estimate from NSSO 62nd (2005-2006) round Unit Level data on Employment and Unemployment Situation in India.

An important dimension is the rural-urban divide. This factor did not get proper attention in the mainstream literature of child labour. The incidence of child labour might be lower in the rural areas due to the strength of traditional ties providing some cushion to the families in stress. However, in the urban areas such sources are missing. Table 5 shows a brief comparison about the incidence of child labour in rural and urban regions. This table shows that incidence of child labour, for both types and age groups, is relatively high in urban area than in rural area.

Table 6: Incidence of child labour according to sex of the house head (% of total child)

Name of the variables	Male headed families	Female headed families
Incidence of child labour (6-14) years	31.15	27.93
Incidence of child labour (10-14) years	18.85	19.31
Incidence of potential child labour (6-14) years	7.11	9.31
Incidence of potential child labour (10-14) years	4.32	5.17

# Source: Authors' estimate from NSSO 62nd (2005-2006) round Unit Level data on Employment and Unemployment Situation in India.

Table 6 helps to compare the incidence of child labour between the households, which are headed by a male member, and the households, which are headed by a female member. From this table we have seen that incidence of child labour, aged 6-14 years, is relatively high for the families headed by a male member compared to the families headed by a female member. But we have found exactly opposite picture for the child labour aged 10-14 years. That implies children of the female-headed families come to labour force at a relatively higher age. However, incidence of potential child labour is relatively larger for the female-headed families compare to male-headed families. This implies that the conversion of child labour from potentiality to reality is much lower for the female-headed families.

3.3 Pattern of Child labour

Let us now consider the pattern of child labour- what are the type of jobs our children are doing. Tables 7 and 8 show the pattern of child labour for our sample. NSSO divides total child labour into eight classes. These eight classes may be grouped into four broad categories: (i) child labour in household enterprises (ii) child labour as regular/casual wage labour (iii) child labour in domestic services (iv) destitute child labour.

It is clear form Table 7 that household enterprises dominate for both the age group; it is near 41% for both the age groups.

The incidence of domestic child labour takes the second best position; it is more than 28% for both the age groups.

Wage employment of child labour is also sizeable in our sample; it is 26.9% for the age group 6-14 years and 27.49% for the age group 10-14 years. Unlike the other three categories, this category shows a different trend. For this category incidence increases as age increases, that means children come to wage work at a higher age.

Again, the last category is worst from welfare point of view. It represents the distress child labour because in this category children's activities are begging, prostitution, etc. representing the worst form of child exploitation. It is disgraceful fact that this category constitutes near 4% for both the age groups.

Table 7: Pattern of child labour (% of child labour)

Categories	6-14 years	10-14 years
Household enterprises (including unpaid family workers)	41.01	40.74
Wage labour	26.9	27.49
Domestic servants	28.29	28.04
Destitutes	3.8	3.73

# Source: Authors' estimate from NSSO 62nd (2005-2006) round Unit Level data on Employment and Unemployment Situation in India.

Table 8: Pattern of potential child labour (% of potential child labour)

Categories	6-14 years	10-14 years
Worked but did not work due to sickness	33.69	32.75
Worked but did not work due to other reasons	26.52	27.97
Unemployed	38.71	39.28
Did not seek but was available for work	1.08	0

# Source: Authors' estimate from NSSO 62nd (2005-2006) round Unit Level data on Employment and Unemployment Situation in India.

Table 8 shows the pattern of potential child labour. NSSO divides potential child into six classes, these six classes may be grouped into four broad categories to facilitate our analysis: (i) Worked but did not work due to sickness (ii) Worked but did not work due to other reasons (iii) Unemployed (iv) Did not seek but was available for work. From table 8 we have seen that nearly 39% of total potential child labours are unemployed. This implies high supply pressure of child labour in the child labour market that reduces child wage as well as adult wage rate (if we assume that child labour and adult labour are substitute). Percentage of child unemployment increases as age increases that mean as age increases more and more children come to child labour market. Nearly 33% potential labour worked but did not work due to sickness. This implies a poor health condition of the children.

4. Results of Basic Econometric Analysis

The above analysis was descriptive. To get a proper picture some further analytical study on the determinants of child labour is necessary. However since the incidence of child labour is probabilistic, there may be a large number of families without any child labour. Consequently, Ordinary Least Squares technique is inapplicable here. Instead, one should use some truncated variable technique for this purpose. In our analysis, we have used the Tobit regression technique. Our aim here is to testify the inverted U hypothesis from a pluralistic viewpoint. Since the problem of child labour is multifaceted, we have tried different types of regression models to ascertain the relationship. For this we have considered four sets of alternative specifications of child labour: (a) Age of child labour and its determinants (b) rural-urban incidence of child labour and its determinants (c) Gender of the family head and child labour determinants (d) gender aspect of child labour and its determinants. We could have considered these various aspects within a single set but then the pluralistic nature is lost and it is difficult to disentangle the relevant factors.

Table 9: Tobit regression results (dependent variable: total child labour)

Dependent variable	Total child labour 6-14 years	Total child labour 10-14 years
Independent variables	Coefficient(t statistic)	coefficient(t statistic)
Per capita land	1.7791(2.2468) **	1.1619(1.2968)
Per capita land square	-2.7579(-1.8130)*	-1.3256(-0.93470)
No. of child in the family	0.55251(16.614) ***	0.47878(11.555) ***
Average years of schooling by adult male	-0.10063(-4.8876) ***	-0.16324E-01(-1.4024)
Average years of schooling by adult female	0.23209E-01(1.0851)	0.25211E-01(1.9728) **
Ratio of consumer to male worker	0.10019 (3.4771) ***	0.13329(4.0335) ***
Ratio of consumer to female worker	0.12836(4.5888) ***	0.15700(4.7635) ***
Dummy for sex of the house head	0.17598(1.5226)	0.18770E-01(0.13004)
Sector dummy	-0.12375(-1.6775)*	-0.81150E-02(-0.87137E-01)
Constant	-2.8024(-17.324) ***	-3.7142(-19.553) ***
Log-Likelihood	-2979.8134	-2295.6381
No. of observations	5479	5479

(*Significance at 10% level, **Significance at 5% level, ***Significance at % level,) # (Source: Authors' estimate from NSSO 62nd (2005-2006) round Unit Level data on Employment and Unemployment Situation in India.)

Table 9 shows the Tobit regression results for the first model set. In both the cases dependent variable is total child labour; first case is for the age group 6-14 years, second case is for the age group 10-14 years, and in both the cases, we regress our dependent variable on the same set of explanatory variables. They are per capita land, per capita land square, number of children in the family, average years of schooling by adult male, average years of schooling by adult female, ratio of consumer to male worker, ratio of consumer to female worker, dummy for sex of the house head and sector dummy. We use land as a proxy of family asset. According to the inverted U hypothesis, increase in family wealth may boost up child labour up to a certain point beyond which it starts to decline. The initial upsurge in child labour may be a reflection of need to use family resources more intensively at a cheaper rate. However as income rises, the family may now have enough space for sending their child to school thereby leading to a fall in the use of child labour (Basu, Das and Dutta 2007, Carpio 2007). Given that a sizeable portion of the child labour are in the household sector (that includes unpaid family labour) this effect may be very important. From the regression result, we have seen that in the first case, per capita land is significant at 5% level and sign of the coefficient is positive. This may imply that child labour increase with per capita land holding and vice-versa. If we consider per capita land square then we have seen that it is significant at 10% level. Coefficients of first two factors reflect that child labour increase with per capita land holding but increasing rate of child labour decreases with per capita land holding. Therefore, inverted "U" hypothesis is observed in the first case. If we consider the second regression then we have seen that per capita land is very weakly significant and sign of it is positive and per capita land square is not significant. This may be because adult members of the family think that it is quite natural to send their child to work as they tend to mature and the inverted "U" hypothesis breaks down.

Our third factor is number of children in the family. For our data, the relevant coefficient is highly significant for both the regression. That means child labour increases with the number of children in the family. When number of children increases amount of consumption increases but income remains same so to survive the family adults send their child to work.

Our fourth and fifth factors reflect the education level of the family. From the regression, result we have seen that average years of schooling by adult male is highly significant in the first case and sign of the coefficient is negative. That means schooling of the adult male have a significantly negative impact on child labour. However, average years of schooling by adult female are not significant reflects the fact that family decision about the child depends on only adult male not on adult female. However, in the second regression average years of schooling by the adult male is weakly significant and its sign is also negative but average years of schooling by adult female has a significantly positive impact on child labour. This may be because as adult females are more educated then they cannot give much time to do the domestic works so they divert some of their duties to their older child.

Our sixth and seventh factors measure the family sustainability. On the background of income, a family will be more sustainable if the ratio of consumer to worker is low. From the regression result, we have seen that ratio of consumer to male worker and ratio of consumer to female worker are highly significant for the regression equations. This reflect the fact that as ratio of consumer to male worker and ratio of consumer to female worker falls family gets away from poverty trap and they have no necessity to send their children to work.

Next, we will see the impact of sex of the house head on child labour and for that; we take a dummy for sex of the house head. Our regression results show that this dummy is significant at 10% level for the child labour aged 6-14 years and sign of the coefficient is positive implies that incidence of child labour will be larger for the male headed families than the female headed families. However, this dummy is not significant for the child labour aged 10-14 years. That means as child become older decision about the child send to work does not depend on sex of the family head.

Lastly, we will see the impact of region on child labour. Our regression results show that the dummy variable for region has a significantly (10% level) negative impact on child labour aged 6-14 years but it is not significant for the second regression implies incidence of child labour is higher in urban areas than rural areas at least at the lower age of the children.

Table 10: Tobit regression result (dependent variable: total child labour 6-14 years)

Dependent variable	Rural child labour	Urban child labour
Independent variables	Coefficient(t statistic)	coefficient(t statistic)
Per capita land	0.41819(0.12762)	2.0860(2.4154) **
Per capita land square	-8.9017(-0.57979)	-2.9937(-1.8501)*
No. of child in the family	0.50166(10.854) ***	0.60676(12.776) ***
Average years of schooling by adult male	-0.65464E-01(-2.4752) **	-0.12836(-3.7235) ***
Average years of schooling by adult female	0.32047E-01(1.2434)	0.14141E-01(0.34102)
Ratio of consumer to male worker	0.19766(4.7486) ***	0.22478E-01(0.55742)
Ratio of consumer to female worker	0.19052(4.6736) ***	0.79359E-01(2.0480) **
Dummy for sex of the house head	0.40410E-01(0.26938)	0.31698(1.7774) *
Constant Log-Likelihood	-3.1969(-13.956) *** -1266.2921	-2.6733(-12.119) *** -1702.2764
No. of observations	2803	2676

*(*Significance at 10% level, **Significance at 5% level, ***Significance at % level,) # (Source: Authors' estimate from NSSO 62^{nd} (2005-2006) round Unit Level data on Employment and Unemployment Situation in India.)*

Table 10 shows two regression results for the second set. In both the regressions, our dependent variable, total child labour aged 6-14 years, is regressed on same set of explanatory variables as earlier except sector dummy.

Our regression result show that first two variables per capita land and per capita land square are significant (per capita land square is significant at 10%

level) and have usual sign in urban areas but they are not significant for rural areas. That means inverted "U" hypothesis is hold good in urban areas but not in rural areas. The relative insignificance of inverted U hypothesis in the rural areas is not very surprising. Due to rapid progress of technical expertise, the importance of land in agriculture has declined. This has been substituted by other factors (such as capital assets, supply of irrigation etc.). However, in the urban area land is still important due to its scarcity and locational value. The urban family possessing a large amount of land easily gets credit to start an informal business. Here land may be considered as a proxy of credit collateral. The inverted U may be just a reflection of it.

Our third factor i.e. number of child in the family has a significantly positive impact on child labour is again established in both the area.

Our fourth factor i.e. average years of education by adult male has a significantly negative impact on child labour in both rural and urban areas as earlier. But, fifth factor, average years of education by adult female is not significant in both rural as well as urban areas. That implies decision about the children is solely depends on education of the adult male.

Our sixth factor i.e. ratio of consumer to male worker is highly significant for rural areas and the sign of the coefficient is positive implies that as this ratio increases incidence of child labour rises. However, this variable is not significant for urban areas. If we consider the ratio of consumer to female worker then we have seen that it is highly significant in both the areas. Explanation is not necessary, as given earlier.

Our last concern is on to dummy for sex of the house head which has a significantly (at 10% level) positive impact on child labour for urban areas but it is not significant for rural areas. That implies rural children are at indifferent position whether their family head male or female.

Table 11: Tobit regression results (dependent variable: total child labour 6-14 years)

Dependent Variable	For male headed families	For female headed families
Independent variables	Coefficient(t statistic)	Coefficient(t statistic)
Per capita land	1.7458(2.1491) **	1.8254(0.43033)
Per capita land square	-2.7511(-1.7259)*	-3.5559(-0.50549)
No. of child in the family	0.54927(15.917) ***	0.70479(5.1614) ***
Average years of schooling by adult male	-0.12564(-5.3426)***	-0.88138E-01(-1.1160)
Average years of schooling by adult female	0.65094E-01(2.5510) **	-0.10292(-1.5846)
Ratio of consumer to male worker	0.70041E-01(2.2293) **	0.17631(1.9026)*
Ratio of consumer to female worker	0.14023(4.8093) ***	0.12072(0.94599)
Dummy for sector	-0.86990E-01(-1.1317)	-0.51211(-1.8320)*
Constant	-2.5747(-16.963) ***	-3.0064(-6.9624) ***
Log-Likelihood	-2753.1062	-218.4858
No. of observations	4916	563

*(*Significance at 10% level, **Significance at 5% level, ***Significance at % level,) # (Source: Authors' estimate from NSSO 62nd (2005-2006) round Unit Level data on Employment and Unemployment Situation in India.)*

Table 11 shows two regression results for the third set. In both the cases, our dependent variable is total child labour. From Table 11 we have seen that inverted "U" hypothesis (per capita land square is significant at 10% level) is observed for the families which are headed by a male member but there is no such evidence for the families which are headed by a female member.

One interesting result is that average years of schooling by adult male is not significant for the families which are headed by a female member though it is highly significant for the male headed families and sign of the coefficient is negative as earlier. However, average years of schooling by adult female is significant for the male headed families and sign of the coefficient is positive implies incidence of child labour rises as average years of schooling by adult female rises. This variable is significant (at about 12% level) for the female headed families and sign of the coefficient is negative implies that incidence of child labour decreases as average years of schooling by adult female rises. Thus female heads are more averse to child labour compared to the males.

Next we come to the factor i.e. ratio of consumer to male worker which is significant for both male as well as female headed (at 10% level) families with proper sign as earlier. Again the ratio of consumer to female worker is highly significant, with proper sign, for the male headed families and it is not significant for female headed families.

Lastly, dummy for sector is not significant for the male-headed families but it is significant at 10% level for female-headed families. That means incidence of child labour is higher at urban areas within the female-headed families.

Table 12: Tobit regression results, dependent variables: total male and total female child labour (6-14 years)

Dependent variable	Male child labour	Female child labour
Independent variables	Coefficient(t statistic)	Coefficient(t statistic)
Per capita land	0.36638(0.40359)	3.9083(2.9628) ***
Per capita land square	-0.70052(-0.52453)	-7.1819(-2.2161) **
No. of child in the family	0.45104(10.297) ***	0.56464(12.951) ***
Average years of schooling by adult male	-0.12354(-4.4053) ***	-0.77742E-01(-2.6322) ***
Average years of schooling by adult female	0.11672E-01(0.40096)	0.36912E-01(1.2002)
Ratio of consumer to male worker	0.85137E-01(2.2167) **	0.93754E-01(2.4109) **
Ratio of consumer to female worker	0.83719E-01(2.2571) **	0.14773(3.9144) ***

Dummy for sex of the house head	0.29923(1.8819) *	0.19274E-01(0.11891)
Dummy for sector	-0.16159E-01(-0.16426)	-0.21454(-2.0397) **
Constant	-3.4020(-15.635) ***	-3.8398(-16.726) ***
Dependent variable	(26.91) ***	(25.482) ***
Log-Likelihood	-2098.9261	-1820.1591
No. of observations	5479	5479

*(*Significance at 10% level, **Significance at 5% level, ***Significance at % level,) # (Source: Authors' estimate from NSSO 62nd (2005-2006) round Unit Level data on Employment and Unemployment Situation in India.)*

Table 12 shows two regression results relevant for our fourth model. In the first regression our dependent variable is male child labour aged 6-14 years and in the second regression our dependent variable is female child labour aged 6-14 years. From Table 12 we have seen that inverted "U" hypothesis holds well for the female child labour but not for the male child labour.

Next factor-the average year of schooling by adult male is highly significant for both male and female child labour. However, the average year of schooling by adult female is not significant for both the cases.

If we consider the factors i.e. ratio of consumer to male worker and ratio of consumer to female worker then we have seen that both the factors are significant for both the regression with proper sign as earlier.

Dummy variable for sex of the house head is significant at 10% level with proper sign as earlier for male child labour but not significant for female child labour. That implies incidence of male child labour will be higher if sex of the family head is male.

Dummy variable for sector has a significant impact on female child labour implies that incidence of child labour will be high in the urban areas than the rural areas. But sector dummy is not significant for male child labour.

Now we summarize the results of basic econometric analysis on the light of inverted U hypothesis (table 13).

Table 13: Summary results about inverted U hypothesis

Results	Inverted U confirmed	Inverted U not confirmed
Table 9	6-14 years child labour	10-14 years child labour
Table 10	Urban child labour	Rural child labour
Table 11	Child labour for male headed families	Child labour for female headed families
Table 12	Female child labour	Male child labour

From Table 13 we have seen that if other conditions remain same then in each of the cases, where inverted U hypothesis is confirmed, probability of a child entering the labour market is relatively lower than the cases where inverted U hypothesis is not confirmed. In other words, inverted U hypothesis is more appropriate where the opportunity cost of child labour is relatively high.

There are some children in the age group 6-14 years who are at relatively lower age compare to the age group 10-14 years. However, they have relatively low physical productivity and skill. Probability of such a child being child labour is obviously low, if other conditions remain same. Similarly, probability of an urban child becoming child labour is relatively lower than a rural child, due to demonstration effect. Children of the male-headed families are at a better position than the children of female-headed families. Therefore, chance of a child becoming labour is relatively lower for the male-headed families. Lastly, a female child has relatively lower physical productivity and limited opportunity to work compared to a male child. Therefore, chance of a female child becoming a labour is relatively lower than the male child is.

Thus from Table 13 we have seen that if other conditions remain same then each of the cases, where inverted U hypothesis is confirmed, probability of a child being a child labour is relatively lower than the cases where inverted U hypothesis is not confirmed. In other words, inverted U hypothesis is found well where extreme poverty prevails.

5. Conclusion

Our analysis shows that the incidence of child labour is till now high enough in India. Among the child labour a significant proportion is wage labour. The worst form of child labour i.e. distress child labour though not significant is prevalent. Girl child is continuously neglected here. Children come to labour force at a higher age for the families headed by a female member. Incidence of child labour is higher in urban areas than the rural areas. The verification of the inverted "U" hypothesis of child labour rests on a number of socio-economic factors that determine the probability of child employment with ceteris paribus assumption.

Bibliography:

- Baland, J.-M., Robinson, J., 2000. Is child labor inefficient? *Journal of Political Economy*, 108, 663– 679.
- Basu, K., 1997. Analytical Development Economics. The MIT Press, Cambridge.
- Basu, K., 1999. Child labor: cause, consequences and cure, with remarks on international labor standards, *Journal of Economic Literature* (37), 1083–1119.
- Basu, K., 2000. The intriguing relation between adult minimum wage and child labor. *Economic Journal* 110, C50– C61.
- Basu, K., Van, P.H., 1998. The economics of child labor. *American Economic Review* 88, 412– 427.
- Basu, Kaushik, Das, Sanghamitra, Dutta, Bhaskar (2007) Child Labour and Household Wealth: Theory and Empirical Evidence of an Inverted-U, *Discussion Paper in Economics*, Indian Statistical Institute, Delhi.
- Bhalotra, S., 1999. Is child labour necessary? mimeo, University of Bristol, Bristol.
- Cain, M.T., 1977. The economic activities of children in a village in Bangladesh. *Population and Development Review* 3, 201– 227.
- Carpio Del Ximena V., (2007), Does child labour always decreases with income: an evaluation in the context of a development program in Nica-

ragua, mimeo, University of Southern California and The World bank.

- Cigno, Alessandro, Furio Rosati C., 2001, Why do Indian children work, and is it bad for them? mimeo, University of Rome.
- Dreze, J., Gandhi-Kingdon, G., 2001. School participation in rural India, *Review of Development Economics* 5, 1 –24.
- Emerson, P.M., de Souza, A.P.F., 2000. Is There a Child Labor Trap? Inter-Generational Persistence of Child Labor in Brazil. Cornell University, Ithaca, USA. In Preparation.
- Fields, G.S., 1994. Labor Standards and International Trade. Cornell University, Ithaca, USA.
- Grootaert, C., Kanbur, R., 1995. Child labor: an economic perspective, *International Labor Review* 134, pp.187– 203.
- International Labour Organization, 1996. Child Labour Surveys: Results of Methodological Experiments in Four Countries, 1992–93. International Programme on the Elimination of Child Labour , IPEC.. ILO, Geneva.
- Jensen, P., Nielsen, H.S., 1997. Child labour or school attendance? Evidence from Zambia. Journal of Population Economics,10, 407–424
- Mondal Kumar Subrata, Counting of Child Labour:- Some Concepts and Practice-mimeo.
- Maskus, K.E., Holman, J.A., 1996. The Economics of Child Labor Standards. Department of Economics, University of Colorado, Boulder.
- Parsons, D.O., Goldin, C., 1989. Parental altruism and self-interest: child labour among late nineteenth century American families, *Economic Inquiry* 27, 637–652.
- Psacharopoulos, G, 1997. Child labor vs educational attainment: some evidence from Latin America, Journal *of Population Economics* 10, 377–386.
- Ranjan Ray, Poverty,Household Size and Child Welfare in India, *Economic and Political Weekly*, September 23,2000.
- Ranjan, P., 1999. An economic analysis of child labor, *Economic Letters* 64, 99– 105.
- Ranjan, P., 2001. Credit constraints and the phenomenon of child labour, *Journal of Development Economics*, 64, 81– 102.

- Ratan Khasnabis, Tania Chatterjee (2007), Enrolling and Retaining Slum Children in Formal Schools; A Field Survey in Eastern Slums of Kolkata. *Economic and Political Weekly,* June 2, 2007.
- Ravallion, M., Wodon, Q (2000), Does cheaper schooling means less child labor? Evidence from behavioural responses to an enrollment subsidy, Economic *Journal* 110, C158–C175.
- Ray, R., 1999. Poverty, household size and child welfare in India, mimeo, University of Tasmania.
- Ray, R., 2000. The determinants of child labour and child schooling in Ghana, mimeo, University of Tasmania.

BOOK REVIEW

Bedprakas Syam Roy, ... towards Convergence – A Ready Reckoner for Actions, Knowledge Bank Publishers & Distributors, Kolkata, 2011, pp. 143, Rs. 275.

The discrepancy between the targets and actual achievements in the sphere of development programmes has been an area for universal concern. Such a discrepancy occurs notwithstanding adequate financial allocations made by the Government and other funding agencies to attain higher economic development and bring about improvement in economic conditions of the people, particularly the poorer sections. To overcome this problem, several attempts such as performance audit and outcome-based budget initiatives were made in the past. The 11th Five Year Plan in India fixed some 'monitorable targets' to attain better success towards fulfilling plan objectives. However, the achievements so far with regard to delivery of services to improve socio-economic conditions of the masses do not appear to be satisfactory. In this backdrop, the concept of convergence emerges as an alternative methodology for optimal use of public resources and more effective delivery of services.

The present book discusses in detail this emerging methodology of convergence. The author not only endeavoured to provide a generally acceptable definition of convergence, but also contrasted the concept of convergence with other, comparable, terms like complementary, synergy, consolidation, confluence, blending, and so on. The author also discusses different forms of convergence, namely demand pull and supply push, simple and real, endogenous and exogenous etc. The different models of convergence as attempted by the Ministry of Rural Development, Government of India (in course of implementation of the MGNREGA) and the United Nations Development Programme (in the context of attaining Millennium Development Goals) have been reviewed by the author. The operational format for better convergence of schemes and programmes has been suggested. Further, the administrative support required for better convergence has been clarified. All in all, it is a book intended to highlight the importance of convergence to maximize programme output and attain better result towards delivery of services to the people.

The book is spread over 13 chapters that deal with above-mentioned aspects in considerable detail. As regards the definition of the term convergence, the author views that it would be wrong to consider convergence as mere conglomeration of schemes; it is much more than that. However, convergence involves a mechanism of programme connectivity to obtain higher level of output. Convergence, if attained properly, corrects regional imbalances, reduces income disparities and accelerates growth process. Above all, it helps in optimal utilization of resources to produce maximum output to improve relative social and human development deficit.

Reviewing the convergence mechanism implicit in MGNREGA, the author notes that convergence under this scheme is still fluid and evolving. As a result, different models of convergence have come into being, each trying to define convergence from its own domain related perspective. Sometimes, complementing a job is defined as convergence while in others sharing a part of a work mean convergence. In yet another instance, providing technological support is touted as convergence. Thus, no universally acceptable model of convergence has evolved as yet. The same can be said about the Millennium Development Goals of the UNDP. Here the *laissez faire* approach of individual programme partner continues to focus on some targeted output level specific to a scheme. Naturally, it may not serve the best option for generating optimal outcome of a number of related schemes unless the interconnectivity and harmonious binding are fully harnessed among the output networks in a given local area. All these instances highlight the importance of evolving an appropriate model of convergence. Such a model of convergence, according to the author, should have the following features: (i) it is place or location specific, (ii) the lead scheme within it has backward/forward linkages, (iii) convergence takes place simultaneously with compatible programmes/schemes, (iv) convergence ensures value addition, (v) the schemes are distinct and different from each other which facilitate visibility and transparency, (vi) the schemes are compatible with each other, and (vii) the schemes belong to the same sector so as to relate them in one developmental function.

However, the author admits that convergence often lacks universal acceptability, and all schemes are not convergent friendly. Thus, at the policy level, short-listing of convergent friendly schemes is required. This will also help to identify convergent nodes and workout the roadmap for attaining convergence. The limitation of human angle, audit angle and programme specific target angle need to be considered in convergence implementation format. A required level of knowledge and skill is indispensable for true convergence.

It goes without saying that the book is an extremely valuable contribution in the field of development planning and programme implementation. It is written by a scholar cum development administrator who spent most of his professional life in designing and implementing various policies for

INSTRUCTIONS TO AUTHORS:

- The Arthaniti considers manuscripts for publication on the understanding that the submitted paper represents an original work not previously published, or being considered for publication elsewhere. The Journal has the copyright to all its published articles.
- Manuscripts accepted for review are blind refereed by two or more scholars. In this context, the authors are advised to write papers in a way to keep their identity from referees. The first page of the text should not reveal the name(s) of the author(s).
- Three hard copies of the manuscript should be sent to Professor Sarbajit Chaudhuri, Editor, Arthaniti, Dept. of Economics, University of Calcutta, 56A, B. T. Road, Kolkata 700 050, India. Authors are also required to send electronic version of their papers (in MS Word format) to sarbajitch@yahoo.com.
- Manuscripts should be in English and between 4,000 and 8,000 words (15-30 pages). They should be double- spaced and typed on standard letter-size (11 x 8.5) paper.
- The cover page should include the author's name, institutional affiliation, and the title of the paper. Please include the contact person's full address, phone, fax numbers and e-mail address. Include the name(s) of any sponsor(s) of the research contained in the paper, along with grant number(s). Supply an abstract of up to approximately 100 words for all articles. It should also contain at least one classification code according to the JEL Classification and five keywords.
- Only essential mathematical notations should be used. All equations and statistical formulae should be neatly typed and numbered consecutively throughout the text in Arabic numerals.
- Footnotes should be kept to a minimum and numbered consecutively throughout the text with superscript Arabic numerals
- References should be quoted in the text as name and year within brackets and listed at the end of the paper alphabetically. Where reference is made to more than one work by the same author published in the same year, identify each citation in the text as follows: (Johansen, 1988a), (Johansen, 1988b). Where references include three or more authors the form (Johansen et al., 1988) should be used in the text. All references must be complete and accurate. Online citations should include date of access. If necessary, cite unpublished or personal work in the text but do not include it in the reference list. References should be listed in the following style: Johansen, S. (1988): Statistical analysis of cointegrating vectors, *Journal of Economic Dynamics and Control* 12, 231-254. World Bank. (1994) *Adjustment in Africa: Reforms, Results and the Road Ahead.* Oxford University Press, New York.
- Tables should be numbered consecutively in the text in Arabic numerals and printed on separate pages.
- Illustrations. Supply each illustration on a separate sheet, with the lead author's name and the figure number, with the top of the figure indicated, on the reverse. Supply original photographs; photocopies or previously printed material will not be used. Line artwork must be high-quality laser output (not photocopies). Tints are not acceptable; lettering must be of a reasonable size that would still be clearly legible upon reduction, and consistent within each figure and set of figures. Supply artwork at the intended size for printing.
- Final version of the papers must be submitted on CD in MS Word 2000 / Word Perfect 6.0 along with two hard copies.
- Final proofs will also usually be sent to the author for checking. This stage is to be used only to correct errors that may have been introduced during the production process. Prompt return of the corrected proofs, preferably within a week of receipt, will minimize the risk of the paper being held over to a later issue.
- Each contributor will receive one complimentary copy of the journal issue in which his/her paper appears. Additional reprints and copies of the journal may be ordered against advance payments.

EDITORIAL/ BUSINESS OFFICE:

Department of Economics
University of Calcutta
56A, B.T. Road, Kolkata 700 050, India.

SUBSCRIPTION RATES:

Indian: Institutions:	Overseas: Institutions:
Rs. 300 (Annual)	US $ 40 (Annual)
Rs. 750 (3 Years)	US $ 100 (3 Years)
Individuals: Rs. 150 (Annual)	Individuals: US $ 25 (Annual)
Rs. 375 (3 Years)	US $ 60 (3 Years)
	Air Surcharge: US $ 5 (optional)

All right reserved. No part of the contents of this journal may be reproduced in any form without the written consent of the publisher.

Published by Department of Economics, University of Calcutta, Editor Sarbajit Chaudhuri & Sankar Kumar Bhaumik on behalf of the Department of Economics, University of Calcutta

Printed at : Calcutta Univeristy Press

Computer Type Setting & Designing : Suban
33/A, Biplabi Pulin Das Street,
Kolkata - 700009

Front Page Design : Suban